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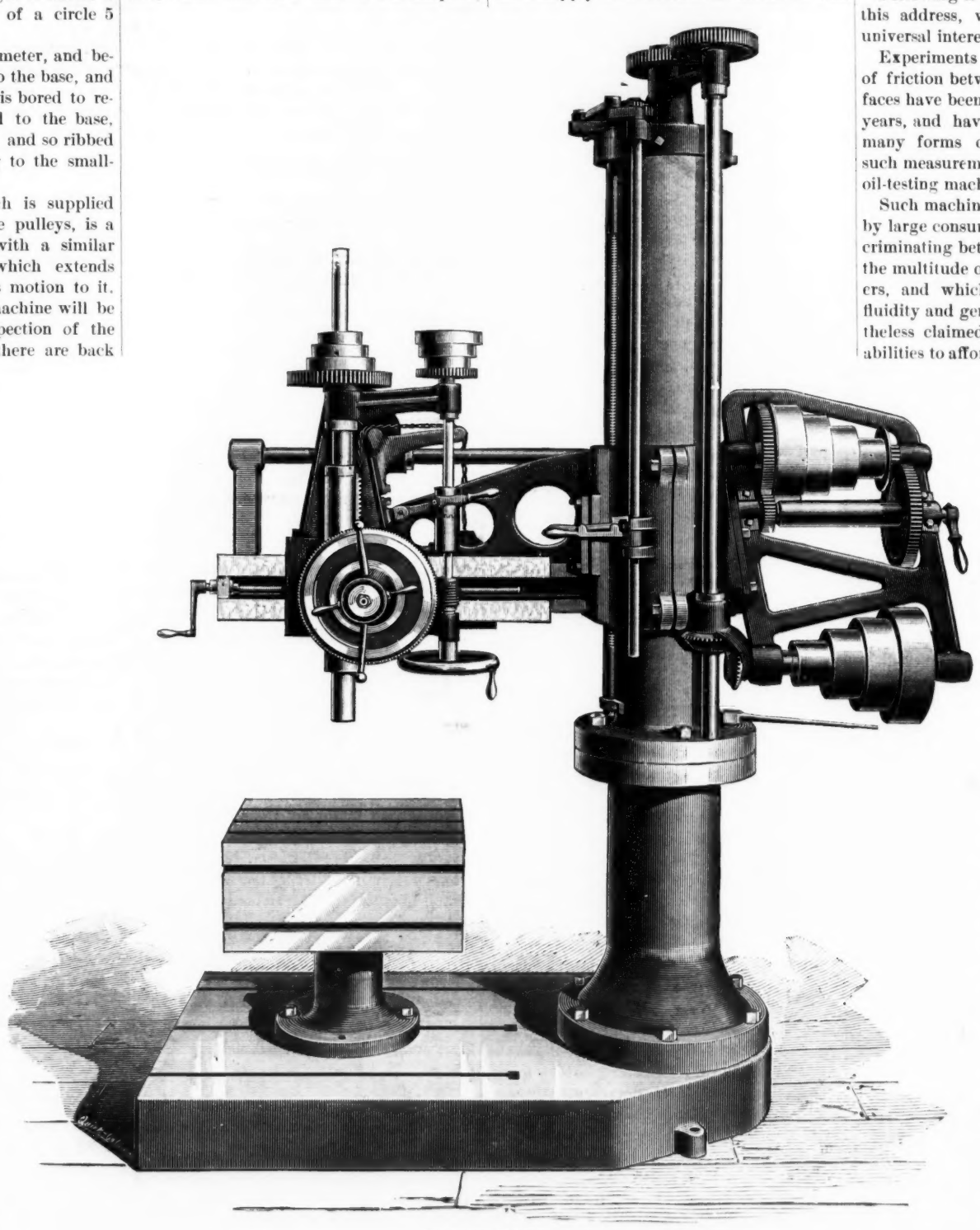
Radial Drill.

On this page we give an illustration of a radial drill, built by Smith & Silk, Eighth and Lock streets, Cincinnati, Ohio.

The arm is of sufficient length to enable a hole to be drilled in the center of a circle 5 feet diameter.

The column is 9 inches diameter, and below the flange it is extended to the base, and turned to fit the stump which is bored to receive it, and rigidly attached to the base, this base being of extra depth and so ribbed beneath as to reduce springing to the smallest possible amount.

On the countershaft, which is supplied with the usual tight and loose pulleys, is a bevel gear, which engages with a similar gear on an upright shaft, which extends above the machine and gives motion to it. All other points about the machine will be readily understood by an inspection of the cut, and, as will be noticed, there are back gears, automatic feed with quick-return motion, and a table with both horizontal and vertical surfaces to which work can be attached. This table has planed T slots, and can readily be removed when required. The arm is raised or lowered by power, and has a bearing on the column throughout the entire length of the sleeve. The spindle, which is 2½ inches diameter, and bored to the Morse taper No. 4, is counterbalanced. The height of the column is 6 feet 8 inches; the machine receives under the spindle over the base, 4 feet 9 inches, and over the floor, 5 feet 3 inches. It is driven by a 2½-inch belt, occupies a floor space 2 feet 6 inches by 4 feet 8 inches, and weighs 3,500 pounds.



RADIAL DRILL.

It costs just about as much to operate a sailing yacht as it does a steam launch, so it is said by those who have had experience.

In order to keep the River Seine, at Paris, in a cleaner condition, the sewage is to be conveyed in a conduit, situated in a bed dug in the bottom of the river.

The section of the large California tree that is to be exhibited at Chicago is twenty feet in diameter, and it wasn't the largest section that could be cut from the tree at that. It is as large as could be transported by rail.

Some European governments have been experimenting with guns of much smaller caliber than those ordinarily employed for infantry service. About 30 caliber seems to be the caliber most in favor. The United States government is now making a move in the same direction. We have not any great faith in squirrel guns for war purposes.

Proceedings of the Mechanical Section of the American Association for Advancement of Science.

During the recent meeting of this association, which has been held at Indianapolis, Ind., and Terre Haute, Ind., between the 19th and 27th of August, the following papers were presented:

VICE-PRESIDENT'S ADDRESS, BY PROF. J. E. DENTON, OF HOBOKEN, N. J., ON THE HISTORY OF MECHANICAL TESTS TO DETERMINE THE DIFFERENCE OF VALUE OF LUBRICANTS.

The experiments made by various investigators, commencing about the year 1700 and extending up to the present time, were reviewed for the purpose of showing that the measurement of the co-efficient of friction of lubricants had been the principal, and in most cases the only determination made. Furthermore, such determinations being confined to artificially smooth bearing surfaces, and a supply of lubricant in excess of that common to practice in the lubrication of machinery, none of these investigations have contributed anything toward verifying or explaining such differences of behavior of lubricants as are the basis of claims among practitioners, regarding differences in the ability of one lubricant to avoid hot boxes or excessive heating, when another lubricant maintains the same bearings in a cool and satisfactory condition. It was shown by experiments that such differences of lubricating value could be revealed only by making the conditions of the testing machine bearings afford opportunity for observing the action of lubricants under restricted methods of supply, and when the rubbing surfaces were abraded so as to cause the local generation of intense heat.

Following is a more extensive abstract of this address, which is important from the universal interest in the subject treated:

Experiments to determine the co-efficient of friction between lubricated rubbing surfaces have been prosecuted for two hundred years, and have resulted in the existence of many forms of satisfactory apparatus for such measurement, which are now known as oil-testing machines.

Such machines are now being resorted to by large consumers of oil as a means of discriminating between the lubricating value of the multitude of oils offered by manufacturers, and which, while practically alike in fluidity and general oily qualities, are nevertheless claimed to differ in their respective abilities to afford satisfactory lubrication.

The only difference of behavior of all these lubricating oils shown by the oil-testing machines is simply such differences of frictional resistance as are ascribable to the variation in viscosity of the substances in the fluid condition, and this difference of friction fails to account for the well-attested fact that some of the oils are unable to prevent excessive heating and cutting on heavy machinery bearings, which exhibit no such action when lubricated with other oils.

Experiments were described which have been made with special apparatus constructed for the lubricating committee of the Standard Oil Company, proving that the over-heating of bearings is due to accidental abrasion of the rubbing surfaces, due to the gradual and inevitable variations of the smoothness of these surfaces by metallic wear.

This abrasion generates a comparatively intense heat at some point of the bearings, and tends to vaporize some oils more than others.

Oils which are incapable of resisting excessive vaporization by such accidental heating are those which permit bearings to more frequently overheat than do others not so affected by the heat.

The prevailing oil-testing machines fail to reveal such difference in oils.

1. Because they have invariably been operated with artificially smooth surfaces.

2. Because whenever accidental abrasion takes place, observations are suspended until the heating tendency due to abrasion has been eliminated.

3. Because the oil supply to the testing journals is artificially abundant, instead of being restricted by feeding through practical forms of oil-cups.

Thereby accidental deficiencies of supply, which are frequently the initial cause of abrasion and overheating, are eliminated, and differences among oils depending on their ability to feed more or less uniformly by virtue of capillary action cannot be noted.

It is, therefore, concluded that in order to enable mechanical oil tests to reveal the actual differences of lubricating value among current lubricants, each oil must be tested with a series of conditions of the rubbing surfaces and practical feeding devices which involve opportunities for abrasion and overheating.

The lecture was illustrated by lantern views of various new devices for testing lubricants under the actual conditions of service, and also by samples of bearings which have been in service under various conditions, representing unsatisfactory lubrication.

Explanations were offered of the paradoxical fact that overheating is often relieved by supplying sand or emery to bearings.

A NEW DYNAMOMETER FOR MEASURING THE RESISTANCE OF CUTTING TOOLS, BY PROF. THOMAS GRAY, OF TERRE HAUTE, IND.

This consisted of a lever, supported in roller bearings so as to turn freely about a point in the slide rest of a lathe. The short end of the lever could carry a lathe tool or a drill. The long end of the lever was connected with a diaphragm which pressed upon a vessel of liquid, having a graduated open-ended tube connected with it. A throttle valve in this tube enabled the liquid in the latter to be adjusted to a certain mark when under the pressure due to the unbalanced weight of the longer end of the lever and its attachment. When the work of cutting commenced, a sliding weight on the long end of the lever was adjusted so that the liquid stood at the same point in the tube. Thereby the movement of the sliding weight measures the increased resistance due to the cutting, and the diaphragm serves the double purpose of a dash-pot and a highly sensitive index. Preliminary experiments have been made with the dynamometer, which prove its ability to do its work successfully, it being sufficiently sensitive to measure the effect of the smallest practical differences of cutting speed, thickness of cut and methods of lubricating the tool. The diaphragm principle of dash-pot, combined with index, was also shown to be successfully applicable in transmitting dynamometers.

A MACHINE FOR TESTING MATERIALS BY TORSIONAL STRESS, BY PROF. THOMAS GRAY.

This is an apparatus for twisting bars of iron up to three inches diameter and about five feet long. Provision is made for the measurement of the torsional load necessary to rupture or distort to any given extent, and also for the accurate measurement of the angle of torsion. The apparatus involves no new principles, but is a very vigorous design, and a novelty, in the fact that it provides an accurate means of measuring torsional phenomena upon so large a scale.

AN AUTOGRAPHIC RECORDING APPARATUS FOR ATTACHMENT TO TENSILE TESTING MACHINE, BY PROF. THOMAS GRAY.

This consists of the usual combination of a paper drum and pencil levers for attachment to any form of tension machine, whereby the drum is revolved at a rate proportional to the strain upon the sample, and the pencil against it is made to move parallel to its axis proportionally to the stretch of the sample under test. Dr. Gray's improvements consist in eliminating from the movement of the pencil all influence due to stretching of the parts of the testing machine. One pencil is devoted to recording the stretch within the elastic limit on a sufficiently magnified scale to enable the co-efficient of elasticity to be reliably computed from the diagram. This pencil is thrown out of action when the elastic limit is passed, and another pencil remains in action up to rupture, from whose diagram the coarser element of elongation is obtainable.

The above paper was presented during a session at the Rose Polytechnic Institute, where the apparatus was exhibited in operation.

A SIMPLE METHOD OF SUBDIVIDING INDEX WHEELS INTO ONE THOUSAND PARTS, BY PROF. W. A. ROGERS, WATERVILLE, ME.

The method provides a plan of subdividing a circular surface without relying, as is usual, upon the accuracy of subdivision of some existing dividing engine or index plate. The wheel to be graduated is mounted on a mandrel, so that its surface is available to two telescopes, mounted upon some fixed support, and provided with micrometer eye-pieces. A strip of paper is fastened about the wheel, and then removed, so that the length of the circumference to be graduated is available as a flat surface between two points on the strip. This circumference is subdivided into the required number of parts by any approximate means available. The paper is then re-wrapped upon the wheel, and scratches made upon the latter opposite the approximate subdivisions upon the paper. Each of the scratched subdivisions is now operated upon by the two microscopes in succession, so as to determine the length of each with reference to the first subdivision examined. The values of each of the subdivisions is then tabulated and subjected to a process of averaging by which the error of each is determined within a certain approximate degree of precision. A new subdivision is then made upon the face of the wheel, embodying the result of this averaging process. This series may be examined in turn by the two microscopes, and by the averaging process a still greater degree of precision made available for a third set of subdivisions, and the process continued until any desired degree of accuracy is reached. The process is not a tedious one, compared to any other method of securing equal accuracy, and it is absolutely reliable in its results.

ON THE CONSTRUCTION OF A PERFECT SCREW EIGHT FEET IN LENGTH, BY PROF. W. A. ROGERS.

In this paper Professor Rogers explains his present method of constructing screws within any desired degree of error, which involves improvements over any of the processes which he has proposed heretofore. A tolerably perfect master screw was first obtained from the Fitchburg Machine Company. This was fitted with a nut carrying a telescope, and mounted parallel to a standard measure of length, correctly subdivided into a sufficient number of parts, each of which could be observed by the telescope as the nut of the screw was moved from end to end. By comparing the longitudinal movement of the telescope with the divisions on the standard bar a template is worked out of such a form that when an arm fastened to the nut is made to trail along the template, any irregularities in the screw are compensated by the supplementary travel of the nut caused by the curvature of the template. The deflections of the master screw out of a straight line by its own flexure are also included in the corrective influence of the template by focusing the microscope on a mercury surface, which has been shown previously by Prof. Rogers to afford an accurate means of correcting for flexure. The master screw having been thus studied and provided with the template, whereby its nut is obliged to travel with absolute precision, is now made to cut the required screw by allowing the cutting tool to be carried by the nut, while the latter is controlled by the combined influence of the rotation of the screw and the action of its template.

A precision screw, made by the method proposed, was exhibited at the meeting by Professor Rogers, to the great satisfaction of those in attendance.

Professor Rogers was complimented upon his achievement by Mr. J. J. Brashear, the celebrated mechanician of Allegheny, who gave an interesting account of the defects existing in many so-called perfect screws made by methods less comprehensive than that proposed by the professor.

RESULTS OF TEST OF STRENGTH OF SEWER PIPE, BY PROF. M. A. HOWE, OF TERRE HAUTE.

A large number of samples of pipe, from four to eight inches diameter, had been tested by internal hydraulic pressure, resulting in the exhibition of an average tensile strength of about 600 pounds per square inch. Tests by transverse strength of samples on supports eighteen inches apart, with load applied at the middles, both as a statical pressure and as a shock, were in progress, and also by burying the pipe in sand on similar supports and pressing upon the sand. The results of the latter tests were not yet sufficiently digested for publication.

Great variations of strength seemed to be caused by slight differences in the degree of burning to which the pipe was subjected.

THE EFFECT OF INTERNAL STRAINS IN HARDENED STEEL, BY G. M. BOND, HARTFORD, CONN.

Records were quoted showing that standard plug gauges, which were ground to exact size soon after being hardened, altered their size considerably after some months had elapsed without any use of the gauges. It was therefore pointed out as an essential precaution that gauges must be allowed to automatically free themselves of a certain amount of internal strain by the lapse of considerable time after hardening before being ground to standard size.

THE MONEY VALUE OF SOLID EMERY WHEELS, BY T. DUNCAN PARET, STROUDSBURG, PA.

The writer points out that while an enormous increase in the use of emery wheels has taken place in the last twenty-five years, and is still going on, and is, moreover, steadily accompanied by a reduction of cost to the consumer, nevertheless emery wheels are not relied upon or used in industrial establishments to an extent proportional to their relative value as one of the useful cutting tools. It points out that the cause of the latter fact is attributable to the relatively excessive time, space, and cost of properly erecting emery wheels in comparison to ordinary tools, such as lathes, planers, etc. The latter need no special foundation, and but a single countershaft, while emery grinders can produce their best effect only when placed on solid foundations, require often two countershafts, and must, moreover, be provided with an auxiliary machine to properly remove the emery dust.

By the results of extensive tests on a large number of makes of wheels in the possession of the writer, he is also able to show that many of the ideas which prevail among consumers regarding the essential elements of value in emery wheels, are fallacious. For example, many consumers prefer the most durable wheel, because their men are paid by the piece, and their men accept such wheels, not discovering that excessive durability almost always necessitates an excessively small product.

A Scotch firm, who have had an opportunity of learning their error in this regard, have stated that their workmen agreed voluntarily to reduce their prices for piece work if they could have restored to them a certain line of emery wheels which wore away so much faster than more durable wheels previously used, that the employers had withdrawn the faster-wearing wheels. The workmen were able to show that the extra cutting power of the latter wheels made them, on the whole, the cheaper.

Out of fifteen makes of emery wheel ten fell short of obtaining the average cutting effect of $1\frac{48}{100}$ ounces of cast-iron per minute. Wheels are largely in use which could cut but $\frac{4}{10}$ of an ounce per minute, in preference to others which could remove $5\frac{1}{10}$ ounces per minute. The workman, in endeavoring to secure a good product with the slower-cutting wheel, must exhaust himself with the pressure which he must exert, and waste time in resting or in stopping to chip and hack the face of the wheel in order to improve its sharpness, whereas the quicker-cutting wheel will practically maintain its sharpness, automatically, by its more rapid wear, and yet the total cost of its use be less than that of the slower-cutting and more durable wheel.

THE PRINCIPAL ELEMENT OF WASTE IN THE USE OF MACHINE TOOLS, BY OBERLIN SMITH, BRIDGETON, N. J.

The paper points out that the failure to insist, in most machine shops, upon cutting speeds and rates of feed and thickness of cut as great as the driving belt will permit within the strength of the pieces worked upon, is a great and prevalent source of waste, affecting the cost of the product, in many cases, upward of 30 per cent.

NEW PRINCIPLES OF MECHANISM SHOWN BY EXPERIMENTS WITH SPIRAL GEARS, BY O. J. BEALE, PROVIDENCE, R. I.

This paper was published in full in our issue of August 28.

EFFICIENCY OF STANDARD LOCOMOTIVE LINK MOTION COMPARED TO AUTOMATIC CUT-OFF VALVE GEAR OF MODERNIZED HIGH SPEED ENGINE, BY H. P. JONES, PORTSMOUTH, N. H

The author has constructed curves having for their abscissa percentages of stroke and for their ordinates percentages of the total area of valve opening, belonging respectively to the standard type of locomotive link motion and to the Ball automatic cut-off engine at various cut-offs. These curves enable tables to be prepared from which it appears that the automatic engine renders a larger proportion of the port area available than does the locomotive. For example, the automatic cut-off engine at 30 per cent. cut-off permits 43 per cent. of its total port area to be used, whereas only 27 per cent. is available in the case of the link motion.

It is a natural inference that such difference of valve opening would cause considerable difference in the amount of wire-drawing or distortion, as shown by indicator cards.

Examination of indicator cards from the two types of engines show, however, that for equal piston speeds and proportion of port area to piston area the locomotive gear gives indicator cards quite as perfect as the automatic gear, and that the well-known distortion or inclination of the locomotive cards during admission only appears at piston speeds which require a mean velocity of flow of the entering steam above 250 feet per second, which, while frequently demanded in a locomotive, rarely exists in stationary engines which present more perfect indicator cards.

It was further shown by discussion of indicator cards presented, that while the most perfect cards were afforded by "trip motion" cut-off gears like the Corliss, the following conclusions practically apply to all good valve gears, including the locomotive link motion, the automatic cut-off or high-speed engine, the Meyer cut-off and the Corliss cut-off.

1. To avoid more than about one pound loss of pressure between the steam chest pressure and during admission to the cylinder, the mean velocity of the flow of steam through the ports during admission must not exceed 40 feet per second.

2. The admission line remains parallel to the atmospheric line up to a mean velocity of flow of about 250 feet per second, notwithstanding that the loss of pressure between steam chest and cylinder may be upwards of 25 pounds per square inch.

3. Distortion or inclination of the admission line occurs above 250 feet velocity of flow, and in locomotives at 55 miles per hour the velocity of flow is upwards of 400 feet per second. Hence the loss of pressure between the beginning and end of the admission line is upwards of 25 pounds in this type of engine.

USE OF THE LOCOMOTIVE FOR TESTING CYLINDER OIL, BY J. E. DENTON, HOBOKEN, N. J.

It is pointed out that in a standard locomotive with unbalanced slide valve the frictional resistance of the latter with good lubrication amounts to about 500 pounds, and that a component of this force acts upon the reverse lever. Hence when the latter is unlatched and held by hand the latter organ becomes sensitive to changes of frictional re-

sistance of the slide valve. Experiments are quoted showing that, at rates of consumption of upwards of 400 miles to the pint, by using sight-feed lubricators the hand is sufficiently sensitive to note the increase of frictional resistance due to the extra pressure necessary in the steam chest to maintain speed when a train of three passenger cars is increased to four cars. It does not appear that any good oil may not have its rate of consumption gradually reduced to that corresponding to upwards of 400 miles per pint without causing an increase of frictional resistance inconsistent with satisfactory lubrication. Hence by gradually reducing the rate of supply of oil to cylinders of locomotives until the feeling of the reverse lever, as judged by the effort necessary to hold it steady when unnotched, is considerably increased over that corresponding to an excessive supply of lubricant and then trying other oils in the same way, a practical means of testing the relative friction-reducing value of cylinder lubricants is available.

OIL FED THROUGH SIGHT-FEEDING DETROIT CUP, STANDARD 18x24 LOCOMOTIVE.

Date	June 10th	June 12th	June 13th
Train	3 to 4 cars	3 cars	4 cars
Distance	205 miles	206 miles	206 miles
Average steam press.	135 lbs.	135 lbs.	135 lbs.
Lubricator	Detroit	Detroit	Detroit
Miles run per pint	440 miles	515 miles	380 miles

PERFORMANCE OF A 75-TON REFRIGERATING MACHINE OF THE AMMONIA COMPRESSION TYPE, BY J. E. DENTON.

The machine tested was located at the Knickerbocker Brewery, New York City, and was built by the Consolidated Ice Company of Chicago. It had been in use about two years, but was easily put in such perfect condition that the results given below are regarded as representing the best that can be expected from the use of ammonia in machines of this class.

The steam cylinder was double-acting, with Corliss mechanism, and was eighteen inches diameter by thirty-six inches stroke. There were two ammonia cylinders twelve inches diameter by thirty inches stroke, single-acting. The speed of revolution was about fifty-nine per minute. Tests were made at various back-pressures from twenty-eight to six pounds per square inch. The supply of cooling water was varied so as to produce a range of condensing pressure from 105 pounds to 150 pounds per square inch. The temperature of the circulated brine ranged from zero Fahrenheit to twenty-eight degrees. The ammonia circulated was metered in liquid form by a Worthington water meter of special construction. Nine separate trials were made of from twelve to twenty-four hours duration each.

The results gave for the best performance a refrigerating effect per pound of coal equivalent to the production of twenty-four pounds of ice, when the back pressure was 28 pounds per square inch, the condensing pressure 150 pounds per square inch, and the consumption of cooling water about one gallon per minute per ton of ice capacity in twenty-four hours. Such a back pressure does not permit the cooling of brine below about 28° Fahr., but the nominal capacity of the machine is then realized, the exact performance being 78½ tons per 24 hours.

With the same condensing pressure, but with seven pounds back pressure, the refrigerating effect was 14 pounds of ice per pound of coal consumed. The temperature of brine available with the lower back pressure was minus two Fahrenheit, and the capacity is then but about 40 tons, the quantity of ammonia circulated being proportionately reduced with back pressure. These two results were both obtained with the minimum amount of cooling water practicable, assuming the latter to be supplied at about 60° Fahr. By trebling the quantity of cooling water, the condensing pressure was reduced to 105 pounds for either back pressure, and thereby the economy was increased about 33 per cent. These results represent the best economy to be expected from the use of ammonia refrigerating machines driven by non-condensing steam engines.

It was explained that the cost of cooling water at ordinary city prices for water was an equal factor of cost with coal in operating such machines.

Attention was called to the fact that the influence of back pressure and supply of cooling water upon the economic performance were as important as is the effect of different rates of expansion and amounts of boiler pressure in the performance of steam engines, and that the failure of experimenters to take account of differences in these conditions in comparing results of tests of ammonia refrigerating machines has given rise to much erroneous belief regarding differences of economy of machines depending upon the same principles. Such is the case in the reports of tests published by Prof. Schröter, in which the best results obtained from ammonia compression machines were gotten with upwards of 30 pounds back pressure and 100 pounds condensing pressure. The former condition is consistent only with brine temperatures above 32° Fahr., and the latter with an amount of cooling water im-

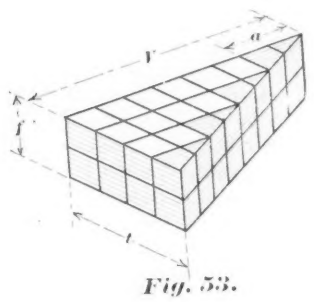


Fig. 53.

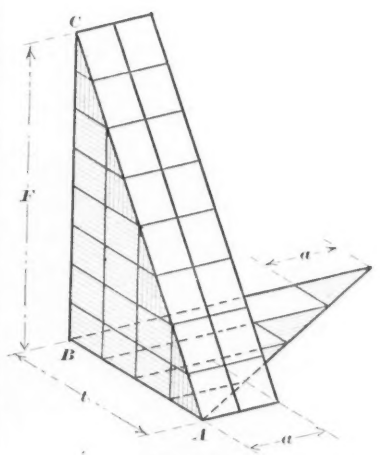


Fig. 54.

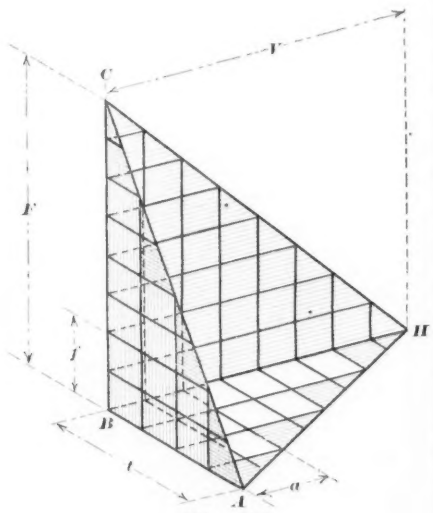


Fig. 55.

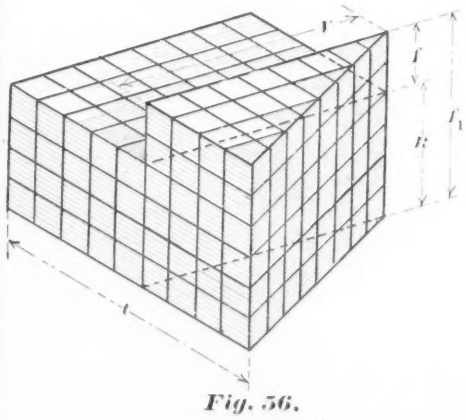


Fig. 56.

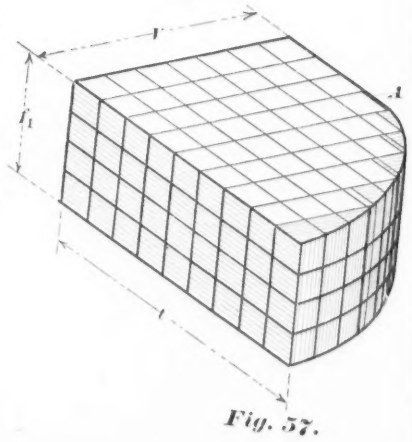


Fig. 57.

practicably expensive, where water is boiled. Should these results be reduced to the basis of the most economical supply of water, the economical results would be reduced upwards of 33 per cent.

It was shown that the experimental results were satisfactorily in accordance with theoretical computations of economy and capacity based upon the thermo-dynamic formulæ presented in the essay on ice machines by M. Ledoux, and published in Van Nostrand's Science Series.

NOTE ON THE GRAPHICAL CONSTRUCTION OF CRANK EFFORT DIAGRAM, BY W. F. DURAND, LANSING, MICHIGAN.

The writer points out that graphical methods are given in certain well-reputed books which are inconsistent with the fact that the oblique action of a crank and connecting rod in the absence of friction have an integrated effect equal to the product of the mean pressure on the piston multiplied by the stroke. Such inconsistencies are worthy of correction, inasmuch as they encourage the erratic notion that the oblique effort of a crank involves loss of power other than that lost by friction.

The following papers were read by title:

THE STRUCTURES OF WOOD AS VIEWED IN THIN CROSS-SECTIONS, BY W. J. BEALE. A STANDARD FORMULA FOR EFFICIENCY OF STEAM ENGINES, BY WILLIAM KENT. A NEW VORTEX LUBRICATOR FOR FAST-RUNNING SHAFTING, BY ST. JOHN DAY.

Force, Motion and Work.

BY PEDRO.

SEVENTEENTH PAPER.

WORK OF UNIFORMLY ACCELERATED MOTION.

If we substitute in Equation 58, sixteenth paper, the value of f_1 from Equation 54, fifteenth paper, and for r, $\frac{1}{2}\ V = \frac{1}{2}\ a\ t$ which, we have seen in the fourth paper, is the average velocity for a uniformly accelerated motion, we get:

$$65\quad \begin{cases} \text{I} \ldots\ldots W = R\,s + \dfrac{w\ a\ s}{g}, \text{ or} \\ \text{II} \ldots\ldots W = \dfrac{R\,a\,t^2}{2} + \dfrac{w\ a^2\ t^2}{2\ g}, \text{ or} \\ \text{III} \ldots\ldots W = \dfrac{R\ V\ t}{2} + \dfrac{w\ V^2}{2\ g}. \end{cases}$$

Now, if there is no resistance to the motion of the body except that of inertia, that is, if there is no physical resistance ($R = 0$), then these equations will reduce to the following:

$$66\quad \begin{cases} \text{I}\,.\,. W = \dfrac{w\ a\ s}{g} = f\,s \\ \text{II}\,.\,. W = \dfrac{w\ a^2\ t^2}{2\ g} = \dfrac{f\ a\ t^2}{2} = \dfrac{F\ a\ t}{2} \\ \text{III}\,.\,. W = \dfrac{w\ V^2}{2\ g} = \dfrac{f\ V\ t}{2} = \dfrac{F\ V}{2}. \end{cases}$$

According to these equations the work required to move any body against inertia resistance only may be variously represented as follows: Like force, work may be represented as a volume, or as a plane, or as a straight line, and may therefore be "composed" and "resolved" in the same manner as force and motion. In Fig. 53 it is represented as a volume in the form of triangular prism whose height, f, represents the static force required to move the body with the acceleration a; the length of the prism is the velocity, V, and the width is the time of motion, t. We recognize in this diagram, on the upper surface, the motion diagram, Fig. 5, fourth paper, which is the area of the end of the prism, and is a measure of the space passed over. This multiplied by the force, or inertia resistance, f, gives the volume which is a measure of the work required to produce the motion, as shown by the third member of Equations 66 (I.) and 66 (III.)

Fig. 54 represents another form of volume which is a measure of the work. This is represented by the fourth member of Equation 66 (II). The height of the geometrical solid in this case is the dynamic force of the body (compare with Fig. 49, fifteenth paper, the triangle $A\ B\ C$ being the force diagram). Its base is a rectangle, the width of which is the acceleration, a, of the body, and the length is the time of motion. Here we see that the area of the *force diagram* $A\ B\ C$, multiplied by the acceleration of the body, gives the work performed by the active agent.

Again, as a surface, the work is represented in Fig. 55 by the area of the triangle $B\ C\ H$, as expressed in the fourth member of Equation 66 (III). The height, $B\ C$, of the triangle is the dynamic force, and its length, $B\ H$, is the velocity of the body. Here the triangle, $A\ B\ H$, is the motion diagram; $A\ B\ C$, the force diagram, and $B\ C\ H$, the work diagram. Each of these work diagrams, Figs. 53, 54 and 55, represents 32 foot-pounds of work.

To set a body in motion in actual practice, we must overcome both the physical and the inertia resistance, as we have seen in the fifteenth paper. The work required, therefore, is given by Equations 65, which is the sum of that represented by Fig. 53 and Fig. 52, sixteenth paper. Representing it in one diagram, it will have the form of Fig. 56, if the physical resistance, R, is constant, and the body is started with a uniformly accelerated motion until it acquires the velocity V; then the driving force, f_1, being suddenly reduced to that of the physical resistance, R, and the body continuing its motion with a uniform velocity equal to V. But the physical resistance to motion generally increases with the speed of the body. Hence, if the driving force, f_1, is constant, the work diagram has the general form of Fig. 57. The motion diagram here resembles that of Fig. 7, fifth paper, the acceleration reducing to zero at the point A. At this point the driving force, f_1, and the physical resistance are equal, and hence there is no surplus force remaining to generate velocity, or to be stored in the body; hence it will move on with a uniform speed until there is a change in either the driving force or the resistance.

In regard to "composition and resolution," as previously stated, work may be treated in the same manner as force and motion, and may be represented by a straight line, a plane or a volume. Its proper measure is the volume, its element being force, velocity and time, *force* being treated here as an element, as explained in Fig. 45, fourteenth paper. In treating work as a plane, two of its elements must be combined and regarded as a single element. For example, if we take the product of force and velocity we get *power*, as we have seen in the sixteenth paper, Equation 59 (1.) Here *power* and the remaining element, *time* (or half the time), are the dimensions of the plane which represents the work, Equations 60 (I.) and 66 (III.)

If the velocity and the time are combined, we get *space* as one "element," and force as the other one, for the dimensions of the *plane of work*—Equations 60 (II.) and 66 (I.)

Again, by combining static force and time, we get *dynamic force* and *velocity* as the elements of the plane of work, which is illustrated in Fig. 55, and Equation 66 (III.)

In steam engine indicator practice the plane is used to represent the work performed by the engine, the two elements, velocity and time, being treated as a single element, space, in which case the work is represented by the two "elements" force (pressure on the piston) and space (the distance traveled by the piston).

As a straight line, work may be regarded in the same manner as force, Fig. 45, fourteenth paper.

Address of National President John Fehrenbatch, at the Ninth Annual Convention of the N. A. S. E.

HELD AT NEW YORK, SEPT. 2–6, 1890.

GENTLEMEN OF THE CONVENTION: I am deeply impressed with the great responsibility devolving upon me as the presiding officer of this vast assemblage of representative steam engineers of America; I am thoroughly imbued with the vital importance of the business for which you are here assembled; I appreciate in the fullest degree the distinguished honor accorded me of addressing this large body of intelligent, progressive and thoughtful men; and I am grateful indeed for the privilege of speaking in behalf of the great mechanical interest you represent—a mechanical interest that has done more for the development of our country and for the advancement of civilization than any other interest—mechanical or professional; a mechanical interest which has become so combined and entwined with the vital interests of the nation that it cannot be destroyed without involving the destruction of the nation itself; a mechanical interest that has contributed in an incalculable degree toward making this country the foremost nation of the earth, and the grandest republic the world ever saw.

In no country have brains and inventive genius done so much to improve and develop the steam engine as they have in the United States of America; and no class of men has contributed more to the grand achievements that have made the American steam engine the wonder, pride and admiration of the civilized world than have the men you represent upon the floor of this great convention to-day; and no agency, past or present, has done more, in so short a time, for the development of the brains and genius of the steam engineers of the United States than has the great National Association whose honored representatives you are.

I am not unmindful of the good work accomplished by the mechanical and engineering press of our country, as it is certainly entitled to the greatest appreciation on the part of our members everywhere, and the most hearty co-operation of our entire organization in all its efforts for the advancement and education of steam engineers.

The mechanical and engineering press has at all times been active and energetic in the advancement of the science of steam engineering, yet during no period of our country's history has it been more zealous, active, energetic or potent in its good work than it has since the adjournment of our national convention one year ago. Neither has it contributed so much toward the growth of our association and the propagation of its principles as it has during the fiscal period now drawing to a close.

We are therefore indebted in a very large degree to the mechanical and engineering press of the United States for the marvelous and unprecedented growth of our association during the past year, as well as for this great gathering of representative steam engineers.

I, therefore, as your executive officer, personally and officially tender the mechanical engineering press of America my sincere and heartfelt thanks for the loyal and unflinching support it has given our association, as well as for the valuable services rendered the cause of steam engineering on the American continent.

We have received the cordial and hearty support of that mighty engine and molder of public opinion, the press, because we deserved it; and we will continue to receive it so long as we deserve it. And with a continuation of that support the principles that bind us in a common bond of national brotherhood are sure to triumph. And when that gladsome day does come, as come it will, and quickly too if we are but true to ourselves and true to the cause we represent, the sacrifice of human life through ignorance, carelessness and recklessness of men in charge of steam plants will cease; a better, brighter and happier day will dawn on the steam engineers of America, and they will take the position in society to which their great services to the public entitle them.

The steam engineer has become a most important and indispensable factor in the industrial and commercial world; and such he is destined to continue until the ingenuity of man has discovered a more economical and mightier power than that of the steam engine. No branch of industry could long survive, nor could trade or commerce thrive without it. No nation can prosper, nor can the resources of any country find development except by and through the instrumentality of that all-powerful and tireless agent. It penetrates the earth and brings from nature's inexhaustible storehouse the most precious metals and the most useful minerals, placed there centuries ago by the great Creator for the use, comfort and pleasure of mankind; it whirls our spindles and drives the looms that weave the cloth we wear; it runs our printing presses that print the newspapers and books that educate and enlighten the world; it melts, rolls and forges our iron and steel; it controls our trade and commerce, and hurls our freight with lightning speed over land and water and across a whole continent in less time than it required, under the old method, to cross a single State a few years ago; it has transformed our beautiful rivers and lakes into great highways of travel and commerce; it shoots across the heaving bosom of the mighty ocean, in majestic splendor and unparalleled fleetness, those matchless greyhounds of the sea, and conveys to every corner of the habitable globe the products of our mines, our workshops and our farms; it annihilates time, defies the hurricane, laughs at the tide, holds in utter contempt the horse-power, windmill, stage coach, and canal boat; in short, it is the power that moves the machinery of the world; it builds hamlets, villages, towns, cities, States, nations and empires; it is in fact as well as in name the majestic monarch of civilization.

Erect a steam engine anywhere on the broad and unbroken prairies of the great West, or in the midst of a howling wilderness, and you lay the foundation for a thriving village; erect two of them, and the village will expand rapidly into a prosperous town; multiply their number and the town will grow quickly into a city of live, energetic and intelligent men and women; add to their number and in an incredibly short time the city will become a great metropolis, with arteries of trade and commerce leading to every part of the civilized world; multiply the cities and an intelligent, powerful and prosperous nation will be the result. It is therefore to the steam engine that this nation owes its greatness more than to any other agency.

While all this is true, the dangers surrounding the operation and management of the steam engine are greater by far and more numerous than those connected with any other machine employed in the generation and transmission of power. Therefore, to obviate and prevent the dangers surrounding the generation and use of steam, and to reduce the number of steam boiler accidents to a minimum, the great National Association, whose representatives are here assembled, was organized. This, then, is the great aim of our society; it is the Alpha and Omega of all its efforts, of all its energies. To accomplish this most desirable result our best efforts are and must continue to be directed toward the education and enlightenment of the steam engineers of America in the arts and science of steam engineering, and the procuring of enactments of the most stringent and efficient license laws by every State in the Union, prohibiting the employment of incompetent, careless, reckless or intemperate men in the care or management of steam plants.

Every State in the Union prohibits by statutory enactments, of the strictest kind, the practice of medicine by incompetent persons. The position of physician is one of the most vital importance to the community. The physician has the care of the health and life of the people, both of which depend, in many instances, upon his skill and knowledge in the practice of medicine. It would, therefore, be dangerous indeed to throw down the barriers wisely erected by law, and permit any one to engage in the practice of medicine without regard to the knowledge and skill so indispensable in the treatment of the numerous ills to which human flesh is heir. Hence it is that no person is lawfully permitted to engage in the profession of physician who does not possess a diploma—or license, if you please—as evidence of his qualifications to be safely entrusted with the life and health of persons committed to his care.

Every State in the Union, as well as the Federal Government, has provided for the better protection of property, human rights, human liberty, as well as human life, by prohibiting the practice of law by all persons except such as have passed a thorough and rigid examination before a legally constituted board of examiners, and received a diploma, or license, as evidence of their qualifications to practice law. If it were not for that the property of the citizen, his rights, his liberty, and in many instances even his life would be placed in jeopardy. The citizen whose title to property is to be determined before a legal tribunal, or whose rights are, or whose liberty is at stake, or who is on trial for his life, is entitled to competent legal services. The statutes, therefore, justly provide that persons ignorant of the law, especially that pertaining to property, human rights, human liberty and human life, shall be excluded from the practice of it.

If it is important, therefore, that the community should be protected against the practice of medicine or law by incompetent persons, how much more important is it then that the community should be protected against the ignorant, careless, reckless or incompetent engineer.

Owing to the absence of any law, with a few isolated exceptions, permitting none but those thoroughly qualified to be entrusted with the important position of steam engineer, thousands of human lives are daily and constantly placed in the most imminent danger, to say nothing of the many annually sent to untimely graves, or of the millions of dollars worth of property destroyed.

The correction of this growing evil is the great aim of our association. To the better protection of life and property in the use and management of steam boilers and steam engines we have dedicated this grand structure—the grandest ever erected by the steam engineers of this or any other country in the world. We have established on the American continent a great national university for the education of steam engineers in the arts and science of steam engineering. And through the instrumentality of this great temple of learning and of science we propose to elevate the men who handle the reins of the iron horse, in the moral, social and intellectual scale, and secure for them a proper and fitting recognition of their eminent services to the community. In short, we purpose to make this grand organization of ours the Alma Mater of the steam engineers of America.

To accomplish this desirable result, and to afford better protection to life and property in connection with steam engineering, it is indispensably necessary that our association should devote its entire energy to the education of steam engineers and to securing the passage of stringent and effective license laws in every State in the Union. To hasten the accomplishment of this laudable purpose, the united efforts of this great convention must be exerted in devising plans for carrying on the work in the most effective and speediest possible manner.

It is not necessary that any radical change should be made in our organic law. Our constitution, with two or three minor exceptions, is all that is necessary for the accomplishment of every purpose for which we are united. What our constitution needs more than anything else is the longest possible period of undisturbed and quiet rest. What few changes are needed should be made before the adjournment of this convention; and let us not return to our homes until we have obliterated from our organic law the provision that would exclude from membership in our association such men as Watt, Stephenson, Fulton, Fairbairn, Roach and Corliss—men who reached the topmost rung in the ladder of engineering fame, and who have had their names indelibly written upon the brightest pages of steam engineering history.

The next thing to be done is to provide laws prohibiting subordinate associations from engaging in any business or enterprise whatsoever, except carrying on the work for which this association was organized—the education of steam engineers, and securing the enactment of laws for the licensing of steam engineers. Each local association should be required to give this important matter its undivided time and attention.

In order to accomplish this great work in the best and speediest, as well as the most efficient manner, this convention should establish a uniform rule of action for the guidance of local associations, the want of which has hindered very greatly the work of securing the much needed legislation in many of the States of the Union. In some parts of the country efforts are being made to secure the enactment of steam boiler inspection laws, while in many places the demand is made for engineers' license laws, pure and simple. The latter, in my judgment, is most likely to be secured. It is the least objectionable to those who would otherwise oppose our efforts or attempt to thwart our aims. Therefore, if this convention will declare in favor of the enactment of license laws, without the steam boiler inspection feature, it will do much toward removing a most formidable opposition and turn it into one of co-operation and hearty support. You, therefore, have it in your power to hasten or delay the day when every steam engine from the Atlantic to the Pacific, and from the lakes to the gulf, will be in charge of a competent and reliable engineer.

I feel confident, however, that you will improve the golden opportunity presented to you, and declare, in language most emphatic and unmistakable, in favor of laws for the examination and licensing of none but competent, safe and reliable steam engineers, and you will have taken a long stride in the work of preventing the destruction of life and property by steam boiler accidents; and God speed the day when this useless sacrifice of human life will cease.

This convention should also, in order to facilitate the work before us, outline the necessary provisions of an efficient license law as a guide for local associations, and to secure a uniformity of action throughout the country. Until that is done the work of securing the enactment of laws on the subject will necessarily be slow and tedious; but lay down a line of action, and every local association under the jurisdiction of this convention will stand loyally and unflinchingly by it.

While you are deliberating upon the all-important subject of license laws, you must not lose sight of the equally important subject of educating our members in the science of steam engineering, and preparing them for successful examination by the inspection officers to be provided by law. No local association must be permitted for one moment to treat this great question in a careless or indifferent manner, or to lag in pushing the work of education and teaching our members how to manage steam boilers without hazard to human life.

It is a well-known fact that steam is a harmless agent in the hands of a competent engineer, and a most dangerous element in the hands of an ignorant or reckless person. For that reason the work of education should be pushed vigorously, and every member of our entire organization should be required to exert his best endeavors in making our local associations worthy branches of this great national academy and training school for steam engineers; for such our organization must ever remain, or fall into speedy decay and crumble into dust.

During the past year numerous efforts were made to divert our association from its original purpose, and make it purely a trades' organization; but I am proud to say that in not a single instance have any such efforts met with any success whatever. In several instances a number of our local associations formed alliances with other associations contrary to the spirit of our constitution; but

the moment their attention was called to the illegality of their act they retraced their steps and returned loyally to the work assigned them by the National Association.

While it is essential to the accomplishment of the objects of our organization that subordinate associations should be held strictly to the line of duty prescribed by our constitution, there should be no restrictions placed upon individual members in connecting themselves with such other organizations as they may see fit and proper, provided such organizations are not antagonistic or inimical to ours or its principles, or in which they are not required to take an obligation that will interfere with the obligations of our order. Further than that this convention cannot, or at least should not, go. No legislation must be attempted that will, in the least particular, interfere with the greatest liberty of our members compatible with the good of our association. But any and all attempts to divert our association from its original purpose, or in any way impair its usefulness, must be met bravely, fearlessly and boldly by this convention. We now enjoy the confidence, respect and friendship of the steam users of America and of the community everywhere; and no act of yours, or of any member of any of our local associations, must be permitted to disturb that relationship or mar the friendship that exists between us.

I deem it unnecessary at this time to advise you as to the details of the work to be performed by this large body of representative men. However, during the course of your deliberations I will be pleased to give such advice and make such suggestions as may be deemed necessary and proper. But as this body is composed of the leading thinking minds of our association, you will need little, if any, advice from any one. I will therefore content myself, merely as a basis of the great work before you, to impress upon your minds the vital importance of keeping constantly in view the objects for which we are organized—education and engineers' license; for it is by and through them, and through them alone, that we can ever hope for a triumph of the cardinal principle of our order: THE PREVENTION OF THE DESTRUCTION OF LIFE AND PROPERTY IN THE EMPLOYMENT OF STEAM AS AN AGENCY IN THE GENERATION AND TRANSMISSION OF POWER.

Yours is, therefore, a sacred mission, and one that should be characterized by the most friendly and brotherly feeling in all your deliberations. Let no personal bickering for a single instant mar the peace and harmony of this great convention, but let your every act be so directed that when you return to your constituents each and every delegate will be met with a "well done, thou good and faithful servant." Remember that this auspicious and momentous occasion may be the turning point in the history of our association. So act well your several parts, that an anxious and hopeful constituency may not be disappointed. Great good is expected as the result of your labors. In fact, deeds are expected at your hands greater by far than any ever performed by any similar convention ever held on American soil. It was expected months ago that this would be the most important convention to the cause of steam engineering ever held on earth. It was expected also that the delegates that would compose this convention would be fully equal to the great emergency which now presents itself. In all of which I am confident that the most sanguine expectations will be fully realized. Therefore, let each and every delegate upon this floor confine himself strictly to the legitimate business for which this convention is held, and all work in harmony and unison for the attainment of the grand objects we are aiming at.

There can be no loftier aim than that of saving or protecting human life, nor one that should commend itself more strongly to the endorsement and support of the community. But no matter how lofty our aims may be, no matter how noble or just our cause, success will never crown our efforts until public opinion has been molded in our favor. This is particularly true here in the United States of America. It is therefore of the most vital importance that this question should also receive very careful consideration at your hands.

The vital importance of this question to the success of our order has been fully recognized by the mechanical and engineering press, especially that portion of it which has so nobly, courageously and loyally championed the great cause you represent, ever since the formation of our association. And all this, to our shame be it said, has been done without aid or encouragement from the National Association. I therefore improve this opportunity, as a recognition of the valuable services in the great cause in which our noble ship has been launched, rendered by the mechanical and engineering press of America, tender that press our most sincere and humble apology, with the promise that never again will our association commit that unpardonable and greatest of all sins—ingratitude. Fully aware of the fact that ingratitude is inherent in human nature, there should be at least one exception to the general rule, if within the power of this association to make it. We owe it to ourselves, our children and posterity; we owe it to our manhood and our reputation as steam engineers engaged in a sacred and holy cause, that we should recognize in the most fitting and proper manner, and show our appreciation of the great services rendered our cause by the mechanical and engineering press. When we have done that we will be in a position to ask and in a position to receive a continuation of the valuable services heretofore rendered.

In order, then, to render those services even more effective in the future than they were in the past, this convention should provide for a thorough organization of the steam engineers of America. Every engineer worthy of the name of engineer, in all the broad domain over which fair Columbia's starry banner waves, should be brought into our fold and enlisted as a soldier in the great cause you represent.

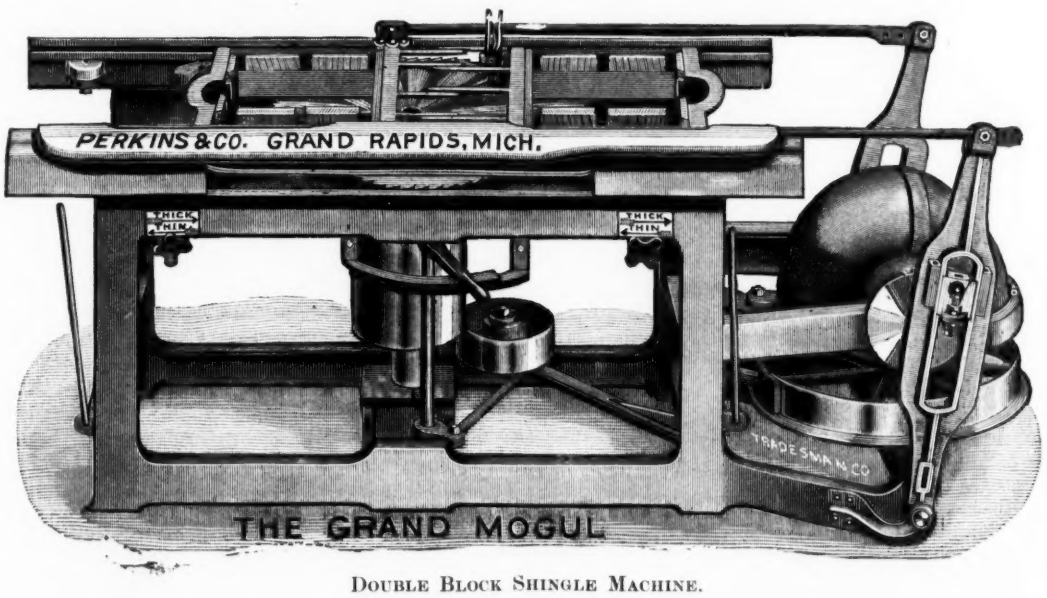
We now have a most formidable organization, extending its branches to every city of importance in the United States. Yet, notwithstanding all that, there are thousands and tens of thousands of intelligent and most worthy engineers who are not enrolled as members of the National Association. The seed is ripe, the time is propitious for garnering a most bountiful harvest; let not, then, this golden opportunity pass without improving it. If this convention will seize the opportunity and take advantage of it, the membership of our association can be more than doubled ere the dawn of another year.

As to the details of the work before you, that is a matter which I will leave entirely with you to arrange as you, in your own good judgment, may deem most proper and expedient, feeling confident that when the work of this great convention is done it will reflect honor and credit upon every delegate. Then let us look to the future, using the past only as a guide for our actions, and the success of our organization will be assured.

In conclusion, let us thank Almighty God for the advancement, progress and unprecedented growth of our association during the past year; let us thank Him for the manifold blessings received at His hands, and for the prosperous condition of our order throughout the country; and especially let us be thankful to Him for this great convention of representative steam engineers of America. That He may continue to shower His blessings upon our order and its members, and upon all who are near and dear to them, should be the earnest prayer of this body. May He also so direct your every act that only great good will follow the adjournment of this great national legislature of steam engineers. May He guard you against all danger and accompany you in safety to your respective homes, to meet the dear ones anxiously awaiting your return.

Before closing I feel it a duty incumbent upon me to return my most sincere and heartfelt thanks to the members of our association everywhere for the uniform courteous and kind treatment, at all times and under all circumstances, received at their hands. And to my colleagues in office I tender my most grateful acknowledgments for their kindness toward me, and for the valuable and efficient services rendered our association and its cause. And I desire especially to thank our members for the great confidence reposed in me and for the prompt obedience of all my official orders, and I most earnestly and sincerely trust that no act of mine will ever mar the friendly relations that exist toward me nor betray the confidence reposed in me.

And now, gentlemen of the convention, I lay down the scepter of executive authority, and return to your care that great trust which one year ago was placed in my keeping at the hands of your predecessors.



DOUBLE BLOCK SHINGLE MACHINE.

Double Block Shingle Machine.

On this page we give an illustration of a machine for making shingles, which is called a "double block" machine, for the reason that a shingle bolt or block may be placed in each of the carriages, one of which can be seen at each side of the machine in the cut, and thus shingles are sawn from two blocks simultaneously, 100,000 to 150,000 shingles per day being a fair output for one sawyer, and reducing the cost of shingles, it is claimed, far below what is possible by any other machine except a rotary.

The machine is so arranged as to be completely under the control of the man operating it, either carriage being stopped instantly by the simple motion of a lever, even when making 120 clips per minute, thus enabling him to pick out what are technically known as "spalts," and place blocks in the carriage while it is standing still.

The tilt-table is also arranged to be adjusted in such a way that any part of the shingles can be altered as to their thickness while the machine is kept in motion, and when one part of the shingle is thus changed no other part is affected by the adjustment, which is made by a screw applied to that particular part.

The general design of the machine is such as experience has shown to be adapted to the work such machines have to do, the saw-arbor boxes, for instance, being so arranged as to be adjusted for lost motion by turning one screw only, and they can readily be ranged in any direction by shifting two screws.

The manufacturers of the machine are Perkins & Co., Grand Rapids, Mich.

Work at Hewes & Phillips.

Business at the Hewes & Phillips Iron Works, at Newark, N. J., is lively, the rush being mainly in their Corliss steam engines and on refrigerating machinery. Although this company has brought out a quite complete line of machine tools, their other lines of business have assumed such proportions that the manufacture of tools has been abandoned. A good many of these tools are in use in the shops. One of them, a planer, with a peculiar strap friction mechanism, that appears to be very effective and satisfactory in its operation, has been in continuous use for several years, with, we are informed, nothing having been done to the friction mechanism in the way of repairs, and it appears to be in all respects as good as new There are some peculiar features of this tool, as well as others of the company's make, that seem to be worth putting to more general use.

The steam engine work of the company is running largely to compounds; one large triple expansion engine is under construction. There are, however, quite a number of simple cylinder engines in smaller sizes being built.

As is the case with a good many builders of high grade steam engines, the Hewes & Phillips shops were run, until lately, with an engine that had come up from a past generation—a verification of the old adage of the unshod condition of the shoemaker's wife and the blacksmith's horse. Recently a new engine-room has been built, and a highly-finished tandem compound engine put in place. This engine has the company's improved dash-pots, and their arrangement for changing, when running, the relative point of cut-off between the cylinders, thereby varying this at will to suit varying demands for power, and hence similarly varying the pressure in the receiver. Both engine and engine-room are models in their way. We are informed that the saving in coal by the use of the new engine is from seven to eight dollars per day. A cheap quality of coal is used; with high-priced coal the saving would be even greater.

We noticed that in the new patterns for engine-beds the Vs are being made much flatter than is customary in the Corliss type of engine, thereby, it would seem probable, reducing the friction. The beds for these engines—and, in fact, all the castings—are fine examples of the molder's art. Nothing finer in the way of such castings can be found anywhere. A good deal of attention is given to making the parts of engines interchangeable by the use of limit gauges.

The company makes pulley fly-wheels up to 28 feet in diameter—possibly larger. One under way was of that diameter, with a nine-foot face. A good deal of pains is taken in putting these wheels together, so as to keep them in balance; they are turned in a pit lathe of very simple and convenient arrangement for the purpose, built at the works.

Overwork is being done in some of the departments, and it is probable the works will be extended before long. The boiler department is overcrowded, and in the foundry it requires some planning and considerable overtime to keep things clear. This is largely owing to the fact that a good deal of outside work is done in this department.

LETTERS FROM PRACTICAL MEN.

Shaft Governors.

Editor American Machinist:

By reading Mr. Armstrong's remarks in your issue of August 21, it occurs to me that in my article of July 31, one of my statements concerning shaft governors might be misunderstood, and I shall try to make my meaning plainer without using too many words. But before I do so I wish to say something about the resistance of a dash-pot. Mr. Armstrong seems to think that the resistance increases in the same ratio as the velocity of the piston, but he gives no good reason for such belief, unless his opinion is based on experiments, for this is, of course, the best foundation of any opinion. I have no recent experiments from which I can judge of the resistance of a dash-pot in relation to the velocity of its piston. But why should it not increase nearly as the square of the velocity? All hydraulic formulas tell us that the velocity of outflow is nearly as the square root of the dynamic head or pressure, and these formulas are based on carefully conducted experiments, and are very valuable to the hydraulic engineer. Why would those formulas not apply to a dash-pot?

Now about my statement, that the smaller the centrifugal force, in proportion to the mass or weight of the ball and other moving parts, the less stability we shall have. This statement is absolutely correct when applied to governors where the ball moves radially, but where the ball does not move radially it would be more correct to put "effective centrifugal" force for "centrifugal force." When the ball does not move radially, we can resolve the centrifugal force into two component forces, one in the direction of movement of the ball, and another perpendicular to this direction. This last component force has no dynamic effect, and may be ignored. The other component force is the only one that need be considered here, and this one is necessarily smaller than the actual or whole centrifugal force. With the ball moving radially there would be no component forces; we should have the whole centrifugal force acting in the direction of motion. Therefore, in that case we should have more *effective* centrifugal force than in the other case. One of the effects of the ball not moving radially will therefore be the same as if we, in a governor where the ball moves radially, had reduced the centrifugal force, absolutely or relatively, by locating the ball nearer the shaft, or by introducing opposing centrifugal forces, or by diminishing the rotative speed, or by using the force of gravity as a counterbalance to centrifugal force instead of springs. The effect would in each and every case be to make the action of the governor slower, for the smaller the effective centrifugal force is in proportion to the mass of the ball and other parts put in motion by it, the slower will the movements be. And this would also be the case, relatively speaking, if we increased the travel of the ball. But *slower motion means less stability*, which I shall try to show without taking up too much space, and without mathematics. But I wish it to be understood that the theory of steam engine governors is one of the most difficult in mechanics, and that a demonstration altogether satisfactory, or easily understood without mental efforts, must not be expected here. I shall not take up the question of tardiness separately here, because it is of no practical consequence in a high speed engine with ample fly-wheel, which also seems to agree with Mr. Armstrong's experience—and because it would make my article too long.

After the governor ball once has been moved out from its position of equilibrium, it will go through a series of oscillations before it comes to rest, and it is the nature and extent of such oscillations that must be analyzed to arrive at a full, correct and general understanding of the conditions of stability in a steam engine governor. The primary cause of such movements is a variation in the amount of load or steam pressure, but the immediate cause is the slight variation in speed following a variation in load or steam pressure. But it is not necessary to consider the first movement of the ball immediately after an increase or diminution of load. We should arrive at exactly the same result, but the analysis would be intricate and unsatisfactory. I shall use diagrams to represent the various forces, under the action of which the governor ball is moving, when it for any reason whatever is out of equilibrium.

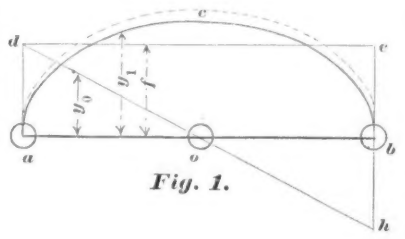


Fig. 1.

In Fig. 1 let *a* represent the ball in its extreme inner position, the engine taking full steam, and let the entire movement of the ball be from *a* to *b*. When the ball is at *b*, no more steam will be admitted than just enough to overcome friction and back pressure. Now, let half the load be thrown on, then the proper position of the ball is at *o*, but it will not stop immediately there; it will keep oscillating for some time equally to both sides of *o*, and the condition of stability is such that these oscillations will be of a continuously decreasing amplitude, which, generally speaking, will be the case if two of the oscillations are of this nature. This may be graphically represented by the zig-zag

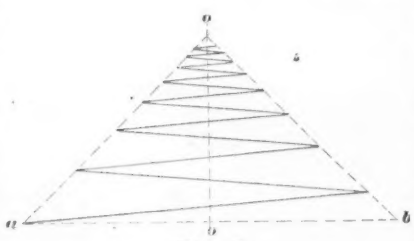


Fig. 2.

line, Fig. 2, showing oscillations extending equally to both sides of a central position *o o*, and diminishing in geometrical progression.

For the sake of simplicity of demonstration, let us suppose the flow of steam to be continuously under control of the governor, as in a throttling engine, then it is evident that while the ball is moving from *o* toward *a* and back to *o*, the engine will be taking more steam than needed, and its speed will consequently be accelerated, and while the ball moves from *o* towards *b* it will take less steam than needed, and the speed of the engine consequently retarded. The speed of the engine will thus be alternately increasing and decreasing, reaching maximum and minimum when the ball is at *o* moving towards *b* or *a* respectively, and mean speed will consequently occur when the ball is at any of the extreme positions *a* or *b*.

It will now be necessary to consider the forces which produce oscillations. There are two forces of different origin, and having very different effects. Suppose we had to do with an isochronous governor; then the ball would be in balance at any position, as long as the rotative speed did not change, but by a changing of the speed of the engine, part of the centrifugal force would be left unbalanced, and this unbalanced force would cause the ball to move. I will call this force y_1; it is represented by the curved line *a c b*, Fig. 1; that is, the magnitude of the force is represented by ordinates to this line, just as the ordinates in an indicator diagram represent the steam pressure. When the ball is at *a* we have mean speed, and, therefore, at that point the force y_1 is *nil*; at *o* we have maximum rotative speed, and, therefore, the greatest value of y_1; at *b* we have again mean speed, and y_1 becomes *nil*. The force y_1 will, of course, also exist in a non-isochronous governor, but there we have another force to deal with, for the ball will not be in balance in every position, with the rotative speed remaining unchanged. It will be in balance in a certain position only, and if moved out from this position will be carried back by a force which increases directly as the distance from the original position, where the ball finally will come to rest. This force I will call y_0. It is graphically represented by the the slanting line *d h*, that is, the vertical ordinates to this line, measured positive upward and negative downward from the horizontal *a b*, represent the force y_0, varying in magnitude and direction as the ball moves from *a* to *b*. It is positive to the left, and negative to the right of *o*; its direction is therefore always towards *o*, where the ball finally will come to rest. Thus the force y_1 is unbalanced centrifugal force due to a variation in speed, and the force y_0 is unbalanced centrifugal force due to a variation in the distance of the ball from the center of rotation.

Suppose y_0 was the only force acting on the ball, then we should have oscillations very much like those of an ordinary pendulum. If there was no resistance or friction, the ball would keep oscillating between *a* and *b* forever; for while the ball moved from *a* to *o*, the direction of force would be in the direction of movement, and the ball would reach its maximum speed at *o*, while from *o* to *b* the force would be in the opposite direction, and as the actual energy, stored in the ball, can be measured by the areas of the triangles *a d o* and *o b h*, it is evident that this would all have been converted into potential energy when the ball reached *b*. But if we only had the smallest amount of friction such oscillations would be continuously decreasing in arithmetical progression. But now we have also the force y_1 to deal with. This force is acting upon the ball in one direction all the time, while it moves from *a* to *b*, and if we had no resistance this force would therefore cause the ball to move with continually increasing velocity, and instead of stopping at *b*, it would at this point attain its greatest velocity. The amount of energy acquired by the ball under the action of the force y_1 is represented by the area *a c b*; all this energy must necessarily be destroyed or converted into another form before the ball reaches *b*, if the oscillations shall be stable. The only known or conceivable form of resistance available for this purpose is friction, and the peculiar resistance discovered by Mr. Armstrong.

Considering ordinary mechanical friction, it will appear that only a limited amount of this can be effective in the manner stated. For the ball cannot commence to move before the accelerating force is greater than the resistance; if, therefore, the friction is greater than the force y_0 at *a*, then the ball will simply stay there till the force y_1 has increased sufficiently to overcome the excess of friction. This initial increase of the force y_1 will simply balance an equal amount of friction, and have no effect on the stability of the governor, and we may therefore ignore it here. The friction which remains is represented by the straight line *d e*, Fig. 1, and the amount of energy it consumes by the rectangle *a d e b*; this then is, generally speaking, the greatest amount of mechanical friction that can have any effect on the stability of the governor; it is equal to the greatest or initial value of the force y_0, and is therefore different for oscillations of different amplitude, and when these become sufficiently small we shall have an excess of friction, however small the whole amount may be. Now, we may generally assume the area *a c b* also to decrease in proportion to the amplitude, and so there will be stability, if area *a d e b* is greater than area *a c b*, that is, when all the energy due to the force y_1 will be consumed by friction. Suppose now that, for any reason whatever, the movement of the ball became slower, centrifugal force remaining the same. Then the period of time during which the fly-wheel is accelerated by an excess of steam pressure would become longer, the increase in rotative speed be greater, and the force y_1 increased in the same proportion, as shown by the dotted line *a c b*, Fig. 1; and the result would of course be less stability. If we should increase the weight of the ball, then the centrifugal force would be increased in the same proportion, and if we ignore other parts moving with the ball, then the velocity of movement of the ball would be unchanged. The force y_1 would be greater, but the force y_0 would also be greater, exactly in the same proportion, and the result as to stability would be the same as before, provided we have an excess of friction. If, however, we by any means whatever should increase the centrifugal force without increasing the weight of the ball, then the force y_1 would be greater on account of the increased centrifugal force. But the fluctuation in rotative speed would also be smaller on account of the quicker action of the governor, which again would have the effect of reducing the force y_1, and the result would be a comparatively smaller increase of this force. The force y_0 would, for the same degree of isochronism, simply increase in proportion to the greater centrifugal force, without being affected by the quicker motion of the ball, which, as before explained, means more effective frictional resistance; or in other other words, the area of friction *a d e b* will increase directly as centrifugal force, while the increase in unbalanced centrigugal force y_1, represented by the area *a c b* in this case, will be considerably smaller, and the result will of course be more stability. The three forces y_0, y_1 and friction *f* combined give the resultant force rep-

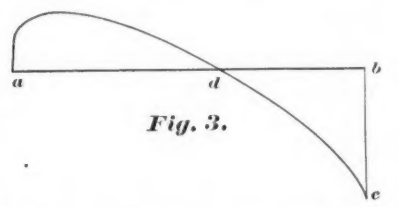


Fig. 3.

resented by the curved line shown in Fig. 3, where the areas above and below the horizontal *a b* should be equal, if correctly drawn.

Having now shown that an increase in centrifugal force in proportion to the mass of the ball, and other parts moving or oscillating with it, will increase the stability of the governor, it will of course not be necessary for me to show that less centrifugal or effective centrifugal force will give less stability under same conditions. But it remains to be shown that an increase or a reduction of centrifugal force, relatively to the mass of the ball and other parts oscillating with it, will so affect the stability of the governor, as to be of some practical consequence; this can only be done by actually working out a few examples, selecting engines and governors of ordinary dimensions. The two forces y_0 and y_1 must be found by calculation, and expressed as functions of the distance of the ball from its central position *o*, and of the time; and the acceleration of the ball for unit of force must be ascertained. A linear differential equation of the third order with constant co-efficients can then be formed, which being solved makes it possible to determine the point where the ball will stop at the end of one oscillation; but the degree of stability can also be approximately determined without solving the differential equation. I shall not go further into the details of this part of the problem, but simply make the statement that I have found by actual calculation the difference in stability under the different conditions here mentioned quite considerable, and certainly deserving the attention of steam engine designers. It should also be remembered that an increase in size or weight of the fly-wheel means a diminution of the force y_1, and consequently more stability to the governor. The main function of the fly-wheel in the modern engine being in fact to support or help the governor, and not to reduce the extent of the small periodical variations of the crank motion, as generally taught.

I hope soon to be able to answer one or two other points in Mr. Armstrong's criticism.

J. BEGTRUP.

A Disclaimer.

Editor American Machinist:

B. Crank, in your issue of August 28, accuses me of "casting a reflection (whatever that may be) upon the character of Capt. Ericsson." I never intended anything of the sort. I merely stated a fact which B. Crank may verify by searching the New York papers of about 1856.

As to B. Crank's statement in effect, "Because the government failed to pay that which was justly due him mechanics should

appreciate his high qualities," I would say that I cannot understand how the fact that a man has a claim against the government can affect any one's judgment as to his character.

I doubt if the government in the long run owed Ericsson anything. His office for several years was filled with government work, and his backer, C. H. Delamater, was the most acute man that the world ever saw in the machine business, and furthermore, of late years there has been no trouble in getting appropriations made for claims in Washington, provided the claims are big enough. WILLIAM H. HARRISON.

Braintree, Mass.

Worm Gearing.

Editor American Machinist:

In Geo. B. Grant's article, Aug. 21, 1890, he does an excellent thing in advocating a diametral unit for worm gear. However, he says:

"One great objection to the use of the circular pitch system for spur gears does not apply to worm gears, that the center distance between the shafts will always be an inconvenient fraction, unless the pitch is as inconvenient. The worm can be made of any diameter, and can, therefore, be made to suit the pitch diameter of the gear, and at the same time the center distance."

Mr. Grant's statement is correct, but I see grave objections to his method of acquiring his center distances. The gear to match the worm is generally produced in cut gears by the aid of a hob, which is usually an expensive tool, and quite desirable to be used on all diameters of gears of a given pitch, except where other reasons than center distance accommodation occur. Mr. Grant's method would require a special hob for every variation in number of teeth in the gear. A change of one tooth to or from the gear will carry with it the characteristics of circumferential measurement, and will demand a special accommodation therefor in the diameter of the worm and its hob.

I highly appreciate any efforts toward the end in question, and I think that it would be well, if, in designing lathes, the matter of introducing into their train of screw-cutting gears a pair of *translating gears*, related 7 to 22, and adopt the diametral unit for worm gearing.

I would be pleased if some of your writers would throw light on the subject of *spiral* gears, cut with standard diametral cutters, and bring about a simplification of their center distances.

In Browne & Sharpe's treatise on gearing, Figs. 21, 22 and 23, is shown the results of a worm hob let into a gear blank at respectively different depths, as regards the true pitch diameter. These illustrations show the gear sectioned at the mid-plane of wheel, and show the addendum of teeth as in contact at the various depths which they may be engaged. This also shows that the worm hob will produce in the gear a contour to the tooth's addendum, which gives *point contact* for every plane within the working face of the gear, which also means that the contact is in *lines* along the face of the working surfaces of the tooth, and *not* point contact, as Mr. Grant seems to think. (See his eleventh paper.)

Mr. Grant also draws attention to the allowability and advisability of increased addendum to worm gear's teeth.

In my practice I take advantage of this allowable variation to correct the evils of center distances consequent upon circumferential measurements of the teeth of gear. And while this variable amount is of no great magnitude, it nevertheless is quite enough to bring the center distances within the common units of measurement familiar to the ordinary mechanic. H. C. HECKERDORN.

That Cupola Explosion.

Editor American Machinist:

The correspondents of the AMERICAN MACHINIST concurring in the statement that the explosion of pistons they have witnessed was caused by confined air expanded by heat, reminds me of a case which happened (in the coppersmith department of the establishment where I was engaged) more years ago than I wish to remember.

The copper float-ball of a steam boiler water gauge had been indented, and its two hemispheres had to be separated so as to hammer out the dents. As usual, in order to unbraze the joint, the ball was heated to melt the spelter; occasionally these balls would explode in separating, and the men would say the air inside did it, but I had noticed that the explosion was much more severe sometimes than at others, and that the amount of mechanical effect was to me much greater than the air-inside theory would justify, so I requested to be called when the next ball would be put on the fire. When notified, I stationed myself in line with the equator of the ball (or copper sphere) until it became red-hot, and as the workmen dodged under the forge there was a deafening sound, and I observed a small puff of steam; then looking around, near a brick wall lay one of the not very hemispherical looking pieces of the ball, showing very distinctly that, in coming in contact with the brick wall, it got the worst of the encounter; the other half lay several feet from the forge, none the worse for its flying excursion; I was then convinced that moisture (or water) in the ball was converted into steam, the tension of which became greater as the ball became weaker, and the latter exploded at the critical moment. This was what I expected, as it was plain to me that it was more rational than to suppose the enclosed air was the cause. When the ball was originally brazed it was heated to the point of fusion of the spelter, consequently the air contained within must have been preciously small, and certainly of very little explosive value. Ah! oh, yes, there must have been a leak for the air to get in. Yes, but this same leak would, no doubt, let high-pressure steam, to which it was exposed in the boiler, enter in also. Likewise a piston might get loaded in the same manner and do great damage, as in the cases recorded by your correspondents. It is certainly easy to conceive that a piston might be porous, or that pin-holes exist around the plugs, and thus, the steam of high tension would pass through until enough got in to balance the pressure in the cylinder, and thus remain imprisoned, until some unfortunate cupola tender, perhaps innocent of physical laws, liberates the hidden force by dumping the piston in the cupola. It ought to be made a rule that no sealed hollow body whatever should be exposed to a high heat, without first being drilled or smashed to pieces.

It may not be out of place here to recall the oft-tried experiment of pouring hot metal, as melted lead, into a wet cavity, the result usually remaining indelibly impressed in the experimenter's memory, even though his eyes have escaped injury.

New Orleans, La. A. E. DUPAS.

That Indicator Pipe—Leakage of Air through Brickwork.

Editor American Machinist:

B. Crank shows up some of my deplorable arithmetic, which was the result of a hasty mental calculation, and the .' (got mixed. The precise amount of loss is of little consequence; it was the fact that there was an unnecessary loss that I was trying to bring out.

Now, according to my critic's method, if the pressure is expanded to the atmosphere, the loss would only be from condensation, and the friction of compression in the pipe. This latter can hardly be work, since the larger the cubical clearance space to be filled, the less will be the pressure opposing the advancing piston, consequently the larger the pipe or clearance, the less would be the counter pressure, and the pipe would become an advantage. Then, if we could eliminate the factor of condensation, we might, according to this method, see an engine with a cylinder double the length of the stroke, and yet working as economically as one with the least possible clearance. If there was no condensation at all, and the steam was expanded as represented, this unnecessary space would still have to be filled and wasted each stroke, and it seems to me that the measure of this loss is the exact amount of steam that it takes to fill this unnecessary clearance, for although it expands precisely as does the steam in the cylinder, if this space did not exist this steam would remain in the boiler for use at subsequent strokes. Of course the expansion of the steam in this pipe does useful work on the piston, but it is at the expense of the boiler that this unnecessary space is filled.

Some time since, Mr. Booth spoke of the leakage of air through the brickwork of furnaces and boiler settings, and, if I correctly understood him, believed that considerable air entered through the porosity of the bricks. No doubt there is altogether too much unauthorized circulation of air around boiler settings, but I am of the opinion that it all comes from poor joints, and cracks, caused by the expansion of parts. In order to see about how porous a brick was, I took an ordinary red one, not a soft, porous one, nor a hard-glazed one, but just an average brick, and, after weighing it, placed it under water for 24 hours, and then weighing it again, I found that it had absorbed 8.4 per cent. of its dry weight, which must be the total porosity, for it had certainly had time enough to become thoroughly saturated. It therefore seems to me that, if average bricks have only this porosity under the conditions named that the amount of air that can pass through them under the slight difference in pressure between the outside and the inside of a furnace would be too small to compute or to take into account.

As to the leakage of air through the cast-iron parts of condensers, that is a pretty hard theory to believe or to disprove, yet if a condenser under my charge should lose its vacuum, that would be about the last thing I should look for, and if it was found to be the cause, I should fear that a coat of paint on the inside would hardly be sufficient to save so poor a casting.

PETER H. BULLOCK.

Critical Notes.

Editor American Machinist:

D. C. Woodward, in "Notes on Machine Design," considers it very bad to have a lathe head-stock adjustable, and thinks it best to have the head-stock cast solid with the bed. Theoretically this may be all right, but if he had struggled as often as I have with the actual problem of boring a straight hole on a lathe that had no tendency whatever to make a straight hole, I think he would welcome any kind of an adjustment that would enable him to get the spindle around in line with the carriage ways. Of course the reply is, that was because the lathe was out of line, either from being wrong at first, or having become so from wear. No matter if the head-stock was in line at first, it will not be long until it is worn out of exact alignment, and if the head-stock is adjustable it can be kept in line without expense for a long time. I would go still farther in that direction, and have a wedge adjustment under the front spindle-box so that the spindle may be kept to the height of the tail center.

The adjustable head-stock can be fastened just as securely as needed by correctly designing it, and I have worked on a lathe with such a head-stock, which was as good as any other lathe of that size I have handled.

"A Mechanic," describing a graduated hub on the handle of the cross-feed screw of a lathe, calls to mind a small lathe which I run in my cub days, and I did not run it long until I discovered the cross-feed and tail-stock screws were 8 threads per inch pitch, and I soon learned to adjust the cut by noting the position of the handle on the cross-feed screw, as one-quarter turn of the handle moved the tool $\frac{1}{32}''$, and I could readily adjust the handle $\frac{1}{8}$ of a turn by the eye, and thus come within $\frac{1}{32}''$ of the required diameter before trying with the calipers. When using the tail spindle for feeding a drill in chucked work, I counted the number of revolutions of the handle of the tail-screw, and could gauge the depth of a hole just as accurately as if measured with a scale

About twelve years ago I saw a lathe with a graduated hub on the cross feed screw handle, but it did not have the adjustable feature, which makes it much more convenient. I agree with "A Mechanic," that a solid gauge is not a convenient thing to use on lathe work, for you cannot tell how near to size a piece is until the gauge will go on, and you have to guess in the "good old way" how much to allow for a finishing cut, or for filing and polishing down to gauge size, unless you have a micrometer to tell how much too large the piece is.

"A Mechanic" gives a good way to face the bottom of a hole to an exact depth, but I have also used two other plans, which can be used without a stop for the carriage. On many lathes the lead screw is 4 threads per inch, and in that case the tool can be set, and the nut thrown in the lead screw, and the screw turned by hand until the tool comes to the required place, when the screw should be stopped. Then the nut should be thrown out, and the carriage moved along any number of quarter inches, then the nut thrown in to engage the screw and hold the carriage in that position, until the facing is completed. I have often used that plan of getting the correct distance from face of one collar or offset to another on a shaft, and it is convenient and accurate, if the lead screw is a true pitch. Care must be taken to take up the slack of the screw in the nut by always pressing the carriage in the same direction at each position, by the traversing handle.

The other way is to set the tool and bring it to the face of the work with the carriage, and then lay a steel rule or scale on the shears of the lathe, so the carriage will pass over it, and slide it under one end of the carriage until the required number of inches the tool is to go in is shown on the scale just even with the end of the carriage; then move the carriage forward and face off the work until the end of the carriage is just even with the end of the rule, and the required depth will be attained. This is much easier, and better than measuring and filing a nick on the tool, for after a while there will be so many nicks on the tool that there is not room for any more. BELL CRANK.

The San Francisco.

It is a fact which has been noted that a dweller on our Pacific coast is inclined to consider it part of his sacred duty to believe and to maintain that whatever worthy things may be done elsewhere, the Pacific coast is the place for the highest and best attainments. Whatever of this sentiment there may be there will most likely be strengthened by the performance of our newest war vessel, the San Francisco, built by the Union Iron Works. The new vessel, it seems safe to say, will have an official record of almost twenty knots, a speed which was maintained during a four hours' run over a measured course. Her speed will be a fraction of a knot above that of the Philadelphia, her immediate predecessor in point of completion, which was designed and built by the Cramps. But whatever of credit there may be in the high performance of the San Francisco, must, we think, be shared by the engineering department of the navy, as this vessel was designed in the Bureau of Steam Engineering, under the supervision of the chief engineer, Lieutenant Melville, so that it is a triumph for him as well as for the builders.

This is the Way They Do It.

The Kansas City & Southeastern Railway, in extending its tracks to West Point, attempted to make a crossing of the Missouri Pacific tracks at Dodson, a way station. The Missouri Pacific tracks had been torn up, when a heavy west-bound freight approached. The train was flagged, but the engineer said he had orders to go ahead, and his train was ditched, effectually preventing the completion of the Kansas & Southern crossing.

The New Haven Railroad, it appears, charged fare above the legal rates to the races last summer. Now the company is being sued by about five hundred passengers who paid the extra fare. The penalty is fifty dollars in each case.

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Small Manufacturers.

Attempts to form great combinations of manufacturers of machinery in this country, after the style of combinations in other industries, are likely to be failures for generations to come at least, principally for the reasons that the effort is always towards improvement in design and construction, that the ability to make these improvements is so widespread, and that anything like a universal standard by which to measure excellence of design and construction of machines, cannot be established. In some industries capital is able, through immense combination, to hold the field against successful competition, because of its ability to use vast sums of money in plants and accessories for doing the work of manufacturing, and in transacting the business, and, if need be, in crushing those of moderate means, who presume to interfere. In such instances, however, the quality of the product must, generally speaking, be easily come at—bounded by definite lines, as it were. For example, a pound of sugar or gallon of oil of a certain easily determined quality, is as good in every way as another pound of sugar or gallon of oil of the same quality. Standards can be set up for measuring the quality of either of these products. But it is not possible to set up such standards for measuring the products of the machine shop. There are no simple tests to which such products can be put, and which will satisfy the purchaser.

Assume that there is, in the instance of the steam engine, for example, a combination of all the best manufacturers in the country, and that the manufacture of these engines is, by the employment of unlimited capital, brought to the lowest point in cost. Let this be accomplished, and the next month, or the next year, a dozen—more or less—better engines, or, what will answer the same purpose, engines thought to be better than those controlled by the combination, will be made; and they will sell, because they are better, or are thought to be; sell for the same reason that one-dollar and two-dollar pocket knives will sell, notwithstanding knives can be bought for twenty-five cents.

So long as the room for improvement exists to the extent that it does in nearly all products of the machine shop, there is little prospect of trusts or extensive conbinations in the business. Men of moderate capital will find opportunities to build good machinery, and to put their product before the buyer; opportunities to grow up from a modest beginning, as most great machinery manufacturers have grown up. The demand for something better is a demand that is never satisfied, and when this demand is met by the individual, he has a chance even against the most powerful combinations.

It is undoubtedly true that it is not so easy to start in a small way in the machine business, as it once was. Modern appliances for doing work at small expense are costly, and the small manufacturer must make shift to get along without many of them. But realizing the disadvantages under which he labors, he makes up for this, in part at least, by increased energy, and the greater attention his limited field of action enables him to give to details, and, if his stock of patience and perseverance does not fail, he has good prospects of marching along with the times. Examples of this are numerous enough to give strength to the courageous. The day of the small manufacturer in the machinery line is by no means past. Failures to succeed may be more numerous, and it is undoubtedly more and more every day a question of the survival of the fittest, but this so in everything.

Fighting Machines.

It is becoming more and more apparent that the battles of the future, whether on land or sea, will be largely contests of machines with machines. The development of modern weapons has gone on at such a pace that it seems not unreasonable to predict that before long what will be required of men who fight battles will be, more than anything else, a thorough knowledge of mechanism, in short, they will be to a great extent mechanics and engineers.

Already the modern naval vessel has become what may be called simply a fighting machine, all its space not required for the men and officers being taken up with intricate and complicated machinery, for doing things which in the old days were done by the men, or left undone. Indeed, the modern war ship has grown so complicated, and done it so rapidly, that it is said many of the older officers of the navy are meeting with considerable difficulty in keeping abreast of the improvements, and that the younger men, fresh from the study of science, and with more ambition to spur them on to further study, are coming rapidly to the front in consequence. It seems that future naval victories are to be won not by the side that has the strongest and bravest men necessarily, but by the side which has its men best protected from the machines of the enemy, and is itself provided with superior machines. All this of course will inevitably bring more and more into prominence the machinist and engineer, and it is beginning to be recognized that some additional effort must be made to secure the best of both on war vessels.

A lesson, which it is to be hoped may not go unheeded, is furnished by the experience of the trustees of the New York and Brooklyn Bridge in acquiring land for the extension and enlargement of terminal facilities at the New York terminus. Property, which it seems might have been foreseen ten years ago would be needed for this purpose, was not secured at that time, through the failure of the board to act in the matter, and now that it has become necessary to have it, it is found that actual values have risen to such an extent that the two cities lose thereby $250,000. And there can be no manner of doubt that the maintenance of the bridge during this time by the two cities has been the chief if not practically the only cause of the increased price. This is a case where a little forethought would have come in very nicely, and it is generally a safe rule for cities which carry through great engineering works to secure at the start all the land likely to ever be needed for use in connection with them, otherwise when it is needed the people will have to pay the increased valuation caused directly by their own original expenditures.

The building and loan associations of the country have struggled along for some years, affording the means through which a large number of workingmen have secured homes, and paying investors good interest. There may have been failures of such institutions, but we fail to recall one. There are no monetary institutions in the country that have been so well managed, and into which peculation has found so few holes to enter. The feeling that everything must be "governed" by the powers that prevail, has never seemed to catch hold of building and loan associations. But a change is imminent. There is at this writing, a convention in session in the State of New Jersey, and this will probably eventually lead to all manner of legislative interference, the end of which will be that a building and loan association will be no surer than a New Jersey savings bank. Not only will the associations in New Jersey be affected, but eventually those of the whole country. It will be a case of too much law.

Events have proven the correctness of the predictions made in our issue of August 7, regarding the replies of boiler manufacturers to the circular issued by the *Safety Valve*, which, notwithstanding its subsequent denial, bore strong inherent evidence of a desire to secure by unfair means from boiler manufacturers a condemnation of our course in calling attention to the evils with which the trade is afflicted. Out of fourteen replies from manufacturers of boilers published by our contemporary, ten agree with statements made by us, while of the remaining four, two evade the questions, and only one answers them negatively. Thus our prediction is completely fulfilled.

As to the charge made against us by our contemporary to the effect that we favor certain manufacturers, and exclude their competitors from representation in our columns, it is not worth replying to. The terms upon which representation in any department of this paper can be secured are made public; any one can ascertain them, and they are well known to be exactly uniform and invariable.

The new navy which the government is creating is rattling the powers that be to some extent. Heretofore it has been considered that engineers must be brought up under government tutelage. But more men are required, and the burning question is, Is it not possible that those brought up outside the government shop may be able to stop and start, and attend to other duties? A great deal of red tape will have to be unraveled before the question is settled.

Literary Notes.

THE LAW OF WAGES, THE RATES AND AMOUNT. By John Richards.

In this book the position is taken that while the rate of wages paid may vary greatly in different countries and in different parts of the same country, the amount paid for wages in the doing of a given amount of work will be practically uniform, and that "a high rate of wages, in this or any other country, is more apt to indicate a lower than a higher labor cost of whatever is produced." The author will be recognized as a well-known mechanical engineer and writer on engineering subjects, and as he himself says in his preface to this little work: "It is not written by a 'doctrinaire' or college economist, but by one who has been a practical workman, a director and employer of labor in several countries, and has investigated facts first and theories afterwards." Numerous facts and instances are cited to show that the highest priced labor is, generally speaking, the cheapest, and the book is full of interest to those who are concerned with the question of the relation of capital and labor, or of employers with employes. The author evidently believes in a high destiny for labor, and has in a fair and manly spirit discussed some of the questions pertaining to its attainment. The book is published by the Industrial Publishing Co., San Francisco, and E. & F. N. Spon, New York. Price 25 cents.

ELECTRICITY FOR ENGINEERS. By Charles Desmond.

It is now quite common to see in one corner of the engine-room of factories and industrial establishments generally a dynamo—usually with a separate engine for driving it—and it is rapidly becoming one of the generally recognized facts that a part of the stationary engineer's business is to know enough of electrical machinery to keep a plant in good order and in the highest state of efficiency. And just as an engineer cannot hope to keep his engines and boilers in the best possible condition unless he studies them and makes himself familiar with their construction and principle of operation, so it is with the dynamo and electrical plant generally. The best engineers will not shrink from this new duty imposed upon them, but will welcome it as giving them additional opportunity for showing the difference between theirs and the merest unskilled labor. This book has been written by a practical engineer and electrician, who has written with a knowledge of just what the practical everyday engineer needs to know regarding the subject, and with the special object of making it plain to him. The book contains just the information needed, and that is being looked for by engineers in charge of electrical plants, and is full of the practical hints and directions that will enable them to work intelligently. The language used is clear and plain, without abstruse problems and mathematical formulas. It is sold at $1.50 per copy by the publishers, The Engineers' Co., 9 Lakeside Building, Chicago, Ill., or Frederick Keppy, Bridgeport, Conn.

POOR'S HANDBOOK OF INVESTMENT SECURITIES. A Supplement to Poor's Manual of Railroads. H. G. & H. W. Poor, New York.

In the editions of Poor's Manual previous to 1889, the range of stock and bond values at the principal exchanges of the country was given in the form of a table. On account of the constantly increasing size of the book this was omitted from the subsequent editions, and to meet the demand for such information this Supplement is now issued. Besides the information spoken of above, it contains a statement of all dividends paid by railroad companies of the United States during the past eight years, and other information useful not only to investors, but to those who, for any reason, wish to make a study of the financial operations of railroads.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(353) L. M., New Britain, Conn., writes: Please let me know what books I should study to learn mechanical drawing. *A.*—We believe that the articles on Practical Drawing which have recently been completed in the AMERICAN MACHINIST will enable you to learn mechanical drawing.

(354) S. J., Coggon, Iowa, writes: Perhaps you would be kind enough to inform me where I can find a school to attend this coming winter where I can study all about machinery and mechanical drawing. *A.*—There is a school at Grinnell, Iowa, close to your home, in which mechanical engineering is taught.

(355) N. M., Paterson, N. J., sends sketches showing two vertical cylinders 3 inches diameter, fitted with pistons, and in the side of each cylinder below the pistons is fixed a pressure gauge. In the top of one cylinder is a pipe 3 inches diameter, and in the top of the other a pipe ½ inch diameter. Both pipes are vertical and straight, and stand 18 inches high. He asks if the pressure on the pistons will be equal when the pipes are filled to the same height with water? *A.*—It will be equal.

(356) J. K. H., Philadelphia, Pa., asks: Will a 2¾x4 inch upright engine, and two or three horse boiler be suitable for a steam launch 25 feet in length, 5½ feet beam, and 3 feet deep? *A.*—The engine may answer your purpose; we should prefer a 3x4 inch engine, which, at 400 revolutions per minute, and with a mean effective pressure of 40 pounds per square inch, will develop about 2.8 horse-power. 2. What size of propeller will be required? *A.*—18 inches diameter, 30 inches pitch.

(357) C. P. R., Buffalo, N. Y., writes: I have been trying for some time to obtain a good liquid for marking on blue prints, and, as I have not succeeded, I would be obliged to you for any receipt you might recommend. I have tried a number of things, and the best results were obtained from common soda dissolved in water, which we are still using, but we are not satisfied with it. It makes a yellow line instead of a white one, and runs over the paper in damp weather, making a very ugly looking print. What I should like to get is a liquid that will make a white line, and not run or spread on the paper. *A.*—We do not know of any liquid that will make perfect white lines on blue prints. Helios erasing fluid is often used for the purpose, but even this will not make a white line, and it will also spread occasionally like common soda dissolved in water.

(358) C. R. S., ———, writes: I have a limited number of ¼-inch round pieces of Stubb's steel to mark with the brand of the firm. I thought of mounting three rollers, on one of which I intended to have the brand. By bringing the three rollers against the work with a good strong pressure I thought I could impress the brand (which is on one of them) into the work quickly and well. Can you or any of your readers give me a better way? *A.*—For our part, if we understand your plan, we should prefer to use only two rollers, one of which would be cut out on the edge to fit the wire, while the other had on its face the stamp to be impressed. The wire would then pass through between the roller in a direction at right angles to their axes. But the job can be done in the regular marking machines, which are made for such purposes, and which have a sliding table, on which the work is placed and run under the marking rolls.

(359) S. W. W., Columbia, S. C., asks: Which is the most economical, and why, a slow or high-speed engine? And which style is being put in most? *A.*—Both types of engines have their advocates; generally the nature of the work which the engine has to do, and the conditions under which it is to be run, will determine the piston and rotative speed. We prefer an engine of medium piston and rotative speed, so as to avoid large steam ports which are required for a high piston speed, and also avoid cylinder condensation as much as possible, which is liable to occur in engine with slow rotative speed. It is difficult to say which type of engine is used the most. 2. What makes the Corliss engine so economical, and why? *A.*—Small clearances and quick cut-offs, which can be adjusted independently of the exhaust valves. 3. Is there any make of engine as economical as the Corliss engine? *A.*—There are other types which have earned an excellent reputation, but it is a difficult matter to build an engine to give as good results as the Corliss engine.

(360) C. S., Cincinnati, O., asks: How can I set the valves in engines with shaft governors? For instance, the directions for setting the valves in some of these engines are, that after the valves, rods, etc., are adjusted, to block up the governor to its running position. Now, is this running position marked on the governor? Or how is it ascertained? *A.*—There are different kinds of shaft governors on the market; and the directions for setting one will not answer for setting another. The best course to pursue is to write to the makers of the engines for instructions in setting the governors. 2. Will excessive lead or compression have a tendency to make an engine work loose on the foundation? *A.*—Excessive lead or compression will prevent the engine from running smoothly, and the consequent jarring will tend to work the engine loose on the foundation. 3. Will not a 10″x12″ engine require more steam and coal than an engine 10″x16″ or 10″x20″, all doing the same amount of work, and running at the same piston speed? *A.*—Both long and short stroke have their advocates; which will use the least steam will depend upon various conditions under which they may be used. No general answer can be given.

(361) E. H. W., ———, writes: I find the following rule for computing the horse power of an engine, given by Roper in his handbooks for engineers: "Multiply the area of the piston by the average steam pressure per square inch; multiply this product by the travel of the piston in feet per minute; divide this product by 33,000, and the quotient will be the horse-power." I have tried this rule several times, but it makes the power of an engine too great. Others have tried it with the same result. The last engine I tried it on was a "Mansfield," 16″x24″, with two semi-rotary valves; steam pressure at engine, 75 pounds; cut-off at half stroke; 150 revolutions. According to the above rule I make the power of this engine over 230 horse-power, which I believe to be a great deal too much. Will you please explain the difficulty? *A.*—You have probably taken the gauge pressure at the engine for the average or mean effective pressure in the cylinder, though even then we do not see how you get the result named. Under theoretically perfect conditions the mean effective pressure in such an engine would be very nearly 60 pounds, which would make the horse-power 219; but practically we should expect that the mean effective pressure would be about 40 pounds, and if so, then the power developed would be 146 horse-power. The rule quoted by you is all right, but it is important to know what the average (or mean) *effective* steam pressure is, and this can, of course, be determined accurately only by the use of the indicator, though experience, under similar conditions, will enable one to approximate it closely by estimation.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Friday morning for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 20.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

"The Bulldozer," a new departure; forging by pressure. M'f'd by Williams, White & Co., Moline, Ill.

Pattern and Brand Letters. Vanderburgh, Wells & Co., 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Ice and Refrigerating Machines, 155 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Adjustable Shrinkage Gauges. Pedrick & Ayer, Philapelphia, Pa.

Link Milling and Slotting Machine. Pedrick & Ayer, Philadelphia, Pa.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Standard Tool Co.'s Twist Drills. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

One Star Hack Saw will do as much work as five of any other kind.—N. B.

Send to H. W. Knight & Son, Seneca Falls, N.Y., for Catalogue of Metallic Pattern Letters and Figures.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

For best Return Steam Traps, Pressure Regulators Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N.Y. Send for des'n.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

"Roper's Hand-Books," for engineers and firemen. Send for descriptive catalogue. Address Edward Meeks, publisher, Philadelphia, Pa.

Horton's Chucks. We offer the balance of our stock at 50 per cent. discount. McFadden Co., Philadelphia, Pa.

25″ 28″ 32″ 36″ Upright Drills a specialty. Finely made, great capacity, quickly operated, prices low. Send for list of firms using our Drills. J. E Snyder, Worcester, Mass.

25″ 32″ 37″ 42″ "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, Newark, N. J.

For Sale—Bound volumes of the Patent Office Gazette for years 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber, 1,936 illustrations, 8vo, cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines. T. C. Dill Machine Co., Philadelphia, Pa.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

MANUFACTURES.

The St. Louis, Arkansas & Texas Railway (office, St. Louis, Mo.,) will erect machine shops and roundhouses in Commerce, Tex.

The Chester Rolling-mills, of Chester, Pa., have increased their capital, and will hereafter be known as the Wellman Iron & Steel Co.

J. F. Peterman, Tacoma, Wash., is enlarging his saw-mill by the erection of a new 60x80 feet addition and a new complement of machinery.

Parties with capital are at Cartersville, Ga., looking into the advisability, and the prospects are good that a cotton factory will be built there.

The Sterling Organ and Piano Company, of Derby, Conn., are to add two new buildings to their already extensive plant, and will begin them soon.

Holland, Mich., has raised a bonus of $7,000, and given twelve acres of land to get a wooden-ware factory, employing 200 men, to locate there.

Prarie du Chien, Wis., is likely to have another factory established before fall, and a new saw-mill built within a year that will employ 150 men.

The file works of Hubbard & Haskill have been removed from Erie to Painesville, Ohio, on account of liberal inducements offered by citizens of the latter place.

The Lebanon & Annville Electric Street Railway company, of Lebanon, Pa., has been organized; Capital, $50,000; eight miles of track. E H. Brooks can give particulars.

J. J. Taylor, A. J. Simpson, A. H. Ellwood and others, have incorporated the Alliance Knitting Company at Tallapoosa, Ga., to erect a knitting mill, etc. The capital stock is $20,000.

A wood pulp paper-mill plant, to cost $100,000, will be established at Ashland, Wis., at once. The new enterprise will open a market for the vast tracts of spruce and poplar in that section.

The Fuller & Johnson Manufacturing Company, of Madison, will remove its plant to Milwaukee, Wis. This company manufactures farm implements and machinery, and employs 300 men.

B. B. & R. Knight, Providence, R. I., have decided to tear down the old mills at Fiskeville and Jackson, in Hope Valley, and build a large mill on the other side of the river, which will utilize both powers.

The Morton Iron Works and the Kelly & Belfont Mills, of Ironton, Ohio, are largely interested in a contemplated steel plant to be erected at Ashland, Ky.; $100,000 of the $4 0,000 capital stock has been subscribed.

The Ellis & Lessig Steel and Iron Company, of Pottstown, Pa., has commenced the erection of a new building to enlarge its puddling department. Two more furnaces will be added to the mill, making 22 in all.

Norfolk and Western capitalists, with a reported capital of $5,000,000, have purchased, or secured options, on 38,000 acres of mineral properties in Southwest Virginia. A steel plant is to be erected at Lambert's Point.

The foundations for a new mill with all modern appliances is being laid by the Wingate Lumber Company, at Orange, Texas. This new firm will be one of the strongest in Texas, as it is composed of two or three strong firms combined.

President Breed, of the Lynn & Boston Railroad, has been authorized to procure a site for the location for an electric power plant in Lynn, Mass. It will be a fully-equipped power plant, costing about $75,000, and probably located on Sea, Broad or Beach streets.

The Osgood Dredge Co., Albany, N. Y., has issued a very neat 1890 catalogue of steam shovels, dredges, excavators, ditching machines and all kinds of excavating and hoisting machinery. The catalogue is well illustrated, and the descriptive matter is to the point.

A fire broke out in Robb & Son's foundry and machine shop at Amherst, N. S., Wednesday night, and they, together with the offices and warerooms and all their contents, were completely destroyed. Several dwelling houses in the vicinity were also burned. The loss is $50,000.

One of the first electric mining plants erected in West Virginia has just been put up by the Thurmond Coal Company at its mines in Fayette County. The plant will cost over $20,000, and will consist of lights as well as mining machinery. The dynamos will be of 350 amperes capacity.

Orr & Jennings have a new machine shop at 311 Fore street, Portland, Maine, and make and repair small engines, and do a general jobbing business in the repair of all kinds of machinery. W. J. Orr, of this firm, has had 16 years' practical experience with the Portland Company.

The Rome (Ga.) rolling-mill has been purchased for $38,500, by B. A. Jenkins, of Knoxville, Tenn.; J. J. Reed, D. R. Beynon and others, who have incorporated the Rome Cotton Tie Manufacturing Company to operate the same. The capital is $50,000, and the plant will be enlarged.

The Tyler Tube & Pipe Company, of Washington, Pa., has now completed a rolling-mill containing an 18-inch three-high train run by a Corliss engine of 300 horse-power. The mill building is 160x80 feet, and the tube-mill is in a building 250x80 feet, which contains a modern gas regenerative furnace.

The Thomson-Houston Electric Co., at West Lynn, Mass., is about to erect a new factory, 190 by 80 feet, three stories high, for heavy machine work in connection with its large dynamos. The building is to be provided with a large traveling crane equipped with three motors for handling the heaviest products.

Savannah, Ga., has the prospect of another cotton factory, and J. L. Whatley has undertaken to raise the money for it. He wants $500 000, and he proposes to locate the factory at Southover Junction. He expects to get the greater part of the required $500,000 at the North, but hopes to get $100,000 in Savannah.

Negotiations are in progress for the removal of the plant of the Born Company, manufacturers of stoves, copper and nickel ware, from Cleveland to Bellevue, Ohio, where some land and buildings have been offered them. The company has agreed to make the change if given $25,000, and to guarantee employment to 100 men.

The Chicago Axe Company has leased the Safe and Lock plant at Hammond, Ind., for five years, with an option for the purchase of the plant at a stated price at any time within that period. The company promises to employ 150 men at once, and to increase the number to 300 within a year. It expects to begin selling the product of the new factory by Oct. 1.

The Schoen Manufacturing Company, of Philadelphia, Pa., which some time since began the erection of new works at Wood's Run, below Allegheny, has nearly completed the plant, and will soon be in operation. The iron building was completed some time ago, and a frame structure for offices is just finished. The hydraulic machinery is being placed in position as rapidly as circumstances will permit.

The Pittsburgh Iron and Steel Engineering Company, of Pittsburgh, Pa., has been given the contract by the Embreeville Iron Company, a large English corporation of Embreeville, Tenn., for a modern 19x80 feet blast furnace. The furnace will use native ores and Pocahontas coke. The Pittsburgh company has also secured contract for the erection of a 30-inch two-high reversing plate mill for the West Superior Iron and Steel Company, of West Superior, Wis. Rolls 30x90 inches will be used, and will be driven by a pair of 36x48 inch engines. The mill will be one of the heaviest built, and will be the first in that section.

The Fuller & Johnson Manufacturing Company, of Madison, Wis., says the *Milwaukee Sentinel*, are contemplating moving their large shops to the latter place. This concern, with the Gisholl Machine Company, which is under the control of the Fuller & Johnson Co., are extensive manufacturers of agricultural implements, fine tools, etc., and employ over 300 men. The main object of the removal to Milwaukee will be to take advantage of the cheap lake freights to the east and south, where a large part of their product goes. In case the concern decides to locate at Milwaukee, which will not be before another year, the company intends to put up a plant that will be equal to any in the country.

I. S. Bangs & Co., of Waterville, Maine, have received the contract for furnishing and laying the foundation of the new pulp-mill at Madison, Maine. Four buildings are to be erected; a wheelhouse, 170 feet square; a digester, so called, a wash-room and a machine-room, each 200x80 feet. The stone is to be the granite from the Dodlin works at Norridgewock, with the exception of a small portion, which will consist of the slate rock excavated in digging the foundation. The amount of the contract for the foundations is in the neighborhood of $60,000, and calls for the laying of 3,000 yards by the 15th of September. This will necessitate the employment of an extra crew of 100 men. Electric lights will be used to enable the force to work nights. The crew on the walls, the excavations and the buildings themselves will all be working at once, and Madison will witness the busiest season in its history.

Messrs. Conover & Co., No. 95 Liberty street, New York City, report increasing demand for their independent steam engine condensers; among recent sales are the following: Four belt power condensers of 350 horse-power capacity each to the Newark Electric Light and Power Co., Newark, N. J. One of 350 horse-power capacity to the Coatsworth Elevator, Buffalo, N. Y. One of 150 horse-power capacity to the Thomson-Houston Electric Co., for the Passaic Electric Light, Heat and Power Co., Passaic, N. J. One of 150 horse-power capacity to the Thomson-Houston Electric Co., Boston, Mass. One of 150 horse-power capacity to the Grand Rapids Brass Co., Grand Rapids, Mich. One of 100 horse-power to Neuman and Rice Flour Mills, Portland, Mich. Two independent steam condensers to the Field Engineering Co., of New York City, for the Buffalo Street Railway Co., Buffalo, N. Y. These two machines are of 800 horse-power capacity each, and are driven by a special compound condensing engine attached directly to the air-pump. The engine is fitted with a Corliss cut-off and dash-pot complete on the high-pressure side and will get about twelve expansions out of the steam.

W. P. Davis, Rochester, N. Y. (works at North Bloomfield, N. Y.,) writes us: "I am just moving into my new shop in this city. It is located directly on the Genesee Falls, having a water-power of 100 feet fall. The building is strictly fire-proof, and is thoroughly heated by steam, and ventilated, having elevators and every modern appliance. We shall be ready to run Sept. 10th. I am putting in quite a large quantity of new machinery, including lathes, millers, planers, grinding machines, etc. I shall continue to operate my works at North Bloomfield, at the present, but my facilities here are such that I am increasing my output of machinery. I shall soon be in condition to furnish promptly, upright drills of the latest improved pattern from 10 inches to 36 inches, and planers from 20 inches to 42 inches, of any length of bed required. Lathes from 10 inches to 30 inches. I shall operate my store as usual, in which we keep a full line of every kind of machine tools that is kept in stock by any machinery house in the country, also tools and supplies. My works here are distinctly separate from my salesroom, and all work will be made in large quantities, thus insuring the best possible tool for the least money. I am in position to ship promptly all goods manufactured by me, and shall soon have out a full line of larger tools."

A special telegram to the *Herald* is as follows: The most stupendous mining deal ever attempted in the West is now pending. It is the sale of all the big mines at Aspen to an English syndicate for $27,000,000. The sum is enormous, and when one looks at the figures at first thought it seems incredible, but when the vast deposit of mineral wealth which they will secure are considered, incredulity gives way to belief. There is no question but that the deal is on, and the facts are as firmly founded as the Aspen Mountain, the great treasure house of nature. About six months ago Cecil C. Morgan, the English mining expert, went to London to dispose of some mining properties, in which John Scott, the wealthy Englishman, who was formerly president of the Colorado Midland Railroad, J. J. Hagerman, the Colorado Springs millionaire, and a number of other parties were interested. Mr. Morgan has been at different times connected with several of the richest mines in the Aspen district, including the Durant, Aspen and Bonny Belle. After considerable work he succeeded in forming a syndicate composed of about fifty financiers of London, representing a wealth of nearly $150,000,000. On his return he began his work of securing an option on the properties very cautiously, and in less than a month the manipulators of the negotiations had secured options on all the leading mines, including the Aspen, Durant, Aspen Mining and Smelting Companies, Franklin, Compromise, Bonny Belle, Johnson, Smuggler, and the Deep Shaft. Some of the figures named were fairly staggering, the Aspen mine being put in at a cool $5,000,000.

Drilling Square and Polygonal Holes.

Several of our English contemporaries of recent date contain descriptions of a new machine which has been perfected there for drilling holes of almost any desired shape. There are two of these machines, both of which resemble an ordinary drill press in general appearance. The first of them, which is called the Ainley-Oakes machine, has a spindle, which is described as consisting of three concentric parts, an outer sleeve to which is attached the bevel gear that does the driving, being connected to an intermediate sleeve by a key-way and feather. On this intermediate sleeve there are formed a number of cams, similar cams being arranged at each end of the sleeve, so that as they revolve in contact with jaws, which can be set up against them by the movement of a screw, this sleeve and the spindle which is within it are given lateral motion, the character, direction and extent of which is determined by the cam in use. There are five of these cams on each end of the sleeve, and there are five sets of jaws, which can be brought into contact with them, one pair of cams and jaws being used for each size or shaped hole which it is desired to produce. The upper pair may be, for instance, arranged to drill a $\frac{1}{2}$ inch square hole, the second $\frac{5}{8}$ inch, third $\frac{3}{4}$ inch, fourth $\frac{7}{8}$ inch and fifth 1 inch. Of course the cutter must be single-ended.

An improvement on this machine has been made by Messrs Tyler & Ellis, by which the number of cams necessary to be used is very much reduced, and the capacity of the machine extended. In this machine there is a sliding head upon the column, which is fed downwards during the drilling, carrying the spindle with it. The spindle is provided with a bearing in this sliding head which is in the form of a sleeve, through which the spindle passes, the sleeve being provided near the middle of its length with a spherical bearing turned truly on the sleeve, and fitting into a socket formed in the sliding head in such a way as to make a ball or universal joint. Just above the upper end of the sleeve the spindle carries the cam which gives the desired swinging motion to the spindle, this cam having its bearing in the upper part of the same sliding head, so that its distance is always the same from the ball joint. The motion imparted to the spindle by the cam is always of greater amplitude than that of the cutter, because the distance from the ball joint to the cam is greater than to the cutter, but this proportion can be changed by simply bringing the spindle down so as to project a greater or less distance through the sleeve, and thus changing the length of the short arm of the lever, so that the swinging motion is more or less reduced, in accordance with the size of the hole to be drilled. Thus one cam is made to do service for all sized holes of the same form, and cams are changed only when the form of hole is to be changed. The fact that the size of the hole drilled depends upon the amplitude of the swinging motion of the spindle at its lower extremity, and the further fact that the extent of this motion, within the limits fixed by the construction of the machine, can be altered by letting the spindle project a greater or less distance through the sleeve, makes the sliding head for giving the vertical motion to the spindle a necessity.

The matter of drilling holes of other forms than round has always attracted a good deal of attention, and there have been numerous attempts to do it in metals, which have not been remarkably successful, though it has been attained in the case of wood-working machinery by means which have been fully illustrated in our columns. Of course the cutter being single-ended, not only makes it much less efficient, considered by itself, than is an ordinary drill, but since the machine spindle has to resist all side thrust resulting from the cut, which is not the case in ordinary drilling, there is another disadvantage resulting from this fact; but nevertheless, according to the reports of those who have seen the machines in operation, it will be possible to produce such holes by their use much more cheaply than it has been possible to do it heretofore, and they will no doubt come into use to some extent.

The Springfield Emery Wheel Company's New Shops.

There was a time not long since when a man who proposed to build a shop usually considered that if he got four walls sufficiently strong to support the floors and the machinery to be placed upon them without serious vibration, and a good roof, he had about all that could be desired; questions of convenience and special adaptation to needs, light, heating and ventilation troubling him very little. Of late, however, the science of what has been called "shopitecture" has been developing, and in some of our modern shops we have evidence of the closest study of special needs connected with the particular work to be done in them. This is particularly noticeable usually in those shops which have been built by concerns that have been in business for some time, gradually enlarging as the growth of the business demanded, until the limits having been reached in this way, it becomes necessary to build entirely new shops, and perhaps seek a new location in which to do it. This has been the case with the Springfield Emery Wheel Mfg. Co., of whose new shops, recently erected at Bridgeport, Conn., we give some illustrations on this and the succeeding page. The experience of the company at Springfield, where a number of rooms in different buildings had been occupied as the business increased, had shown them just what was lacking, and what it would be desirable and practicable to secure in the erection of new shops, and they have gone on in the light of that experience with the result that they have a new plant, which can scarcely fail to be admired by those who have given any attention to such matters.

The main building, of which we give a first floor plan in Fig. 1, page 11, is 50x310 feet, two stories high, with a basement, which is of such character that any part of it can be used for manufacturing operations, if desired, as it is abundantly lighted by numerous windows, the sills of which are above the ground level, and provision is made for heating it by forcing in air charged with surplus heat from the ovens used in making emery wheels.

On the first floor is the machine shop, and in the top story a plant for the manufacture of sand-paper. At the center of the main front is an extension towards the street, as shown by the plan, Fig. 1, and cross-section, Fig. 2, and on the different floors of this extension are located the offices, tool-room and drafting-room. At the right of this is a fire-proof vault, which extends all the way up, being used on one floor, where it opens into the tool-room, for the storage of the more valuable tools, gauges and fixtures, on another for the office, and above for original drawings and records of the drafting-room.

Back of the main building, and about opposite the center of its length, is the building in which emery wheels are made, a plan of this building being shown by Fig. 3. In one corner of this building are the engine and boiler-rooms, while to the left of it is the building in which are located the pattern shop and pattern storage room (not shown), and still further to the left is the foundry, a part of which is shown in plan and elevation by Figs. 4 and 5.

Sidings from the N. Y., N. H. & H. R. R. enter the yard, and are so placed as to enable machinery to be loaded direct onto the cars, and at the rear is a water front with 26 feet depth of water at low tide, so that vessels can enter from Long Island Sound to discharge or take on freight.

The buildings are heated by the hot air blast system, the fan used for this purpose being a Sturtevant, seen in the plan of engine-room (Fig. 3) in the lower left-hand corner. Air passes from the fan over the steam-heated coils, and from thence through an underground passage made of brick to a duct which runs through the entire length of the basement under the main building. This tunnel or duct is seen in cross-section in Fig. 2, where it is shown to be composed of double brick walls with an air space between, and covered by ordinary slabs of stone, such as used for making pavements. This duct connects with four upright flues, which are made part of the rear wall of the building, though they project outwards from it, as shown by Figs. 1 and 2. From these flues there are openings into the various rooms on each floor, which are controlled by swinging dampers for the regulation of the heat The only tin pipes which are used in the system are those which pass from the main duct across the basement and up to the offices, which are also provided with steam heating apparatus, so that, if necessary, they can be heated by steam when the shop is shut down and the fan not running. The fan is driven by an engine attached direct, as shown. Just back of the engine-room is a second fan, which is driven from the line shaft for the purpose of drawing out hot air from the ovens in which the emery wheels are hardened, and forcing it into the basement, thus using heat which would otherwise be wasted for keeping the basement thoroughly dry and comfortable.

In another corner of the engine-room is the engine which at Springfield furnished power for the works, its office now being to drive the dynamo by which the shops are lighted, the system being the Westinghouse incandescent. At the right of the engine-room is a 16″x42″ Corliss engine built by Lane & Bodley, of Cincinnati, which furnishes the power. The main driving belt from this engine passes through a tunnel to the basement of the main building, as shown by Fig. 2, where there is a jack shaft from which power is distributed in the manner indicated, a shaft being placed on each side of the machine shop instead of through the center, so that the center of the floor is left clear for whatever may be required for handling work, and moving it about the floor. Any one of the shafts about the building may be stopped without interfering with the others.

At the left of the engine-room is the boiler-room, in which are two boilers, one for the regular power, and a smaller vertical one for use in emergencies, or when the shops are not running. The space between this building and the main building is paved over, and through it runs a spur from the railroad, vaults being provided below into which coal can be dumped directly from the cars, where it falls directly in front of the boilers, the boiler-room floor being on a level with the bottom of the vaults, and considerably below that of the engine-room, so that there is an unusual distance between the top of the boilers and the roof; there being no wood-work anywhere near the boilers. Teams may also drive in over this vault, and deliver coal in the same manner, should it be desired to do so. At the left of the boiler-room is the blacksmith shop, in one corner of which is the stack, so placed that all the products of combustion from the emery wheel ovens, blacksmith shop and boilers pass into it.

The middle space in this building is occupied by the room in which are located the ovens for baking emery wheels, those at the left being arranged on either side of tracks, upon which runs a small transfer table which can be run on out to the next room alongside the hydraulic press, in which all wheels except those known as the vitrified wheels are molded by hydraulic pressure. On the transfer table, the top of which comes just level with the floor of the ovens, is a small truck on which the wheels are placed and run into the ovens. No great heat is used in these ovens, the wheels baked in them depending mainly upon the various gums used for their strength and hardness, some of the wheels thus made being to a certain degree flexible. At the right of this room is the furnace in which the vitrified wheels are burned. It is made about the same as a potter's furnace, with seven firing places about its outer circumference, and in this furnace a very high degree of heat is attained, various mixtures of clay being used for the cementing material of the wheels, this clay being hardened by burning the same as potters' work or bricks. The vitrified wheels are not pressed, but the material composing them is simply mixed as evenly as possible, and put into molds, where it is allowed to dry sufficiently, so that the wheels can be

turned into shape, which is done on a potter's wheel. They are then still further dried and packed in muffles with quartz for burning. In the rear room of this building are also the lathes used for turning wheels (which is done mainly with diamonds), machines for balancing, and the various appliances for mixing materials.

For lack of space we do not show all of the foundry, but at Fig. 4 give an elevation of the central portion, and a plan showing the arrangement of the cupola, core oven, etc. The core oven is at the center of the length of the building, which is 92 feet 8 inches by 38 feet inside, and, as shown, has a monitor roof. A hydraulic elevator takes iron and coke from the ground to the charging floor. At the left of the Blakeney cupola is the core oven, and to the left of this again the room in which cores are made. The right-hand side of the core oven has large doors opening into the foundry, through which can be run a truck with large cores, and to the left of this space, but not separated from it in any way, are a large number of shelves for smaller cores, numerous small iron doors opening from the core-room into these shelves. There are altogether about fifty of these small doors, so that any part of the shelves is accessible for putting in or removing small cores, and without going into the part where the larger cores are baked. A swinging crane will be put in, which will cover a large portion of the floor. At the extreme left, in an extension of this building, is the pickling-room.

At the extreme right of the main building, Fig. 1, is seen a room which is set apart for the Blake crusher, which is used for crushing the ore from which the cutting material for sand-paper is made. The sand-paper made here is that known as the "garnet," from its red color. The mines from which it comes are controlled by this company, and the ore, when it arrives by cars, is unloaded on the platform seen at the rear of the main building, which is level with the car floors, and also with the first floor of the building. After passing through the crusher it is screened, that which is not yet fine enough being returned to the crusher by an elevator, while that which is sufficiently fine passes to a pair of chilled rolls which pulverize it. An exhaust fan here takes out all that part of the stock which has been reduced to fine dust, as this possesses no cutting qualities, and simply serves to absorb glue to no purpose, the remainder goes through a regular bolting operation, such as is to be seen in any flour-mill, practically the same machinery and the same bolting cloth being used. This separates it into grades according to fineness, after which it is taken by the elevator to the top floor, where the sand-paper is made.

From the paper-mills this comes in rolls of about 350 pounds each, which are put into a machine which draws it through at the rate of about 100 feet per minute, glue being applied evenly by brushes as it passes under them, two large tanks being in the machine in which it is kept hot by steam pipes. Sand is allowed to fall onto it just after the glue is applied, and by a little device, which whips the strip as it passes from one roll to another, the surplus sand is shaken off. It then passes out of the machine and up an incline on rollers and an endless iron chain, sticks having been automatically placed under the strip at certain intervals. When it reaches a point near the roof trusses, it is led off onto traveling carriers, which pass entirely around the room, and at a much slower speed than the paper comes from the machine, so that as it passes to them it is made to hang down in long loops reaching nearly to the floor, the tops of these loops being supported by the sticks previously mentioned. It is passed from one system of carriers to another, each succeeding one moving at a somewhat slower speed than the last, so that as the paper gets nearer dry the loops hang closer together. It it thus kept in motion about the room until sufficiently dry to go to the machine, which cuts it into sheets of the desired size, if it is to be so cut, much of it being delivered to large consumers, however, in continuous sheets. The maximum width of the sheets is 40 inches.

Some of the arrangements of the office are shown by Fig. 5; at the left under the stairway being a group of drawers intended

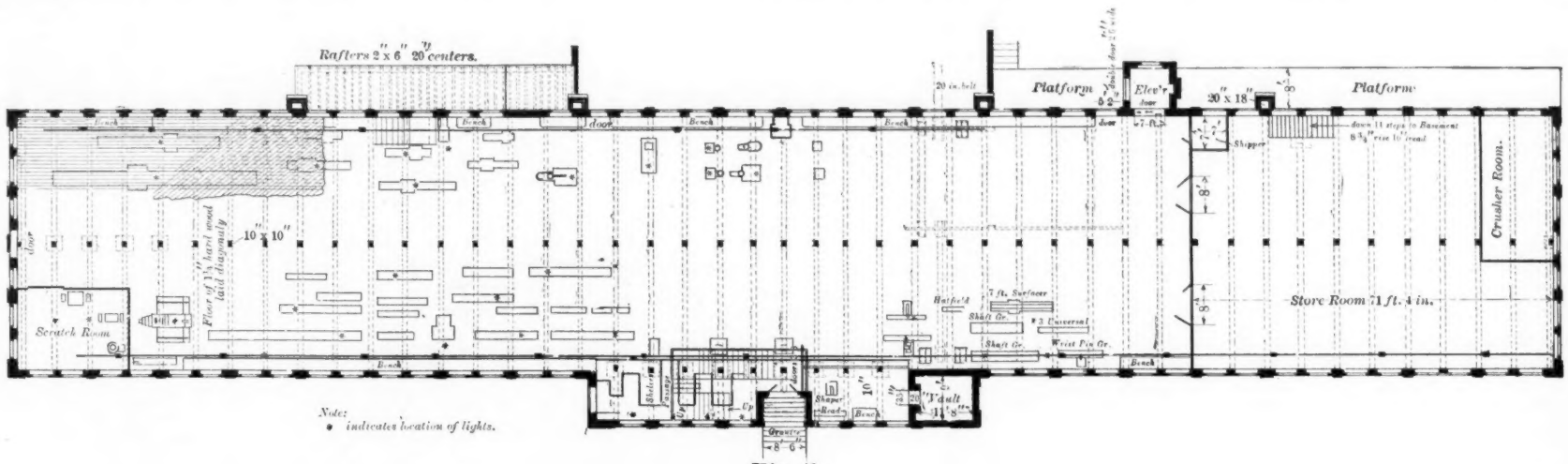

Fig. 1.

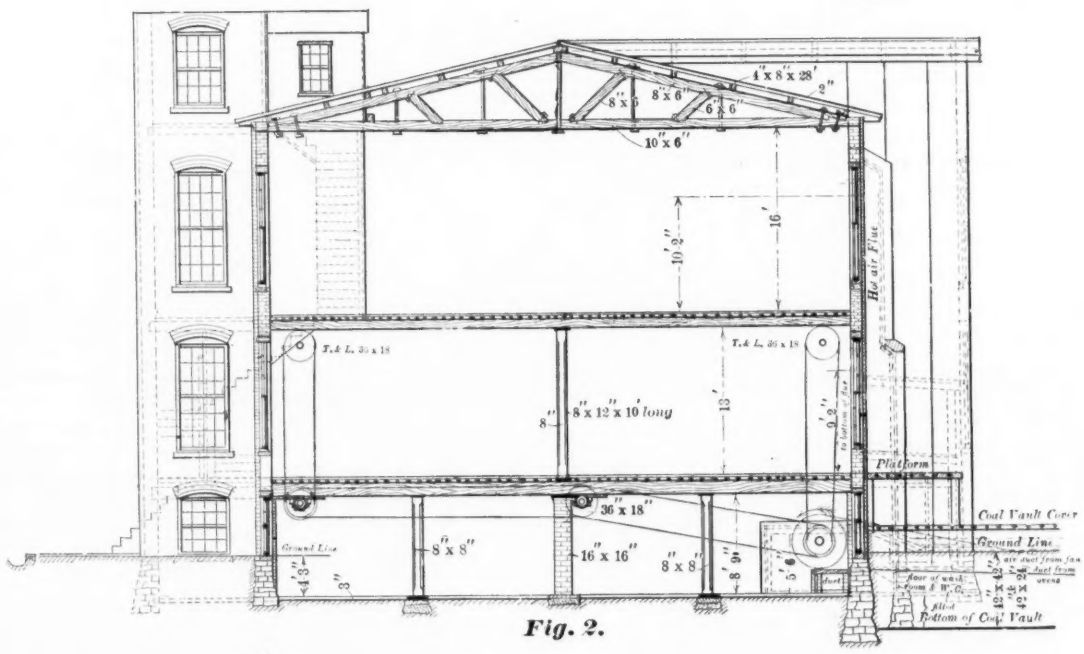

Fig. 2.

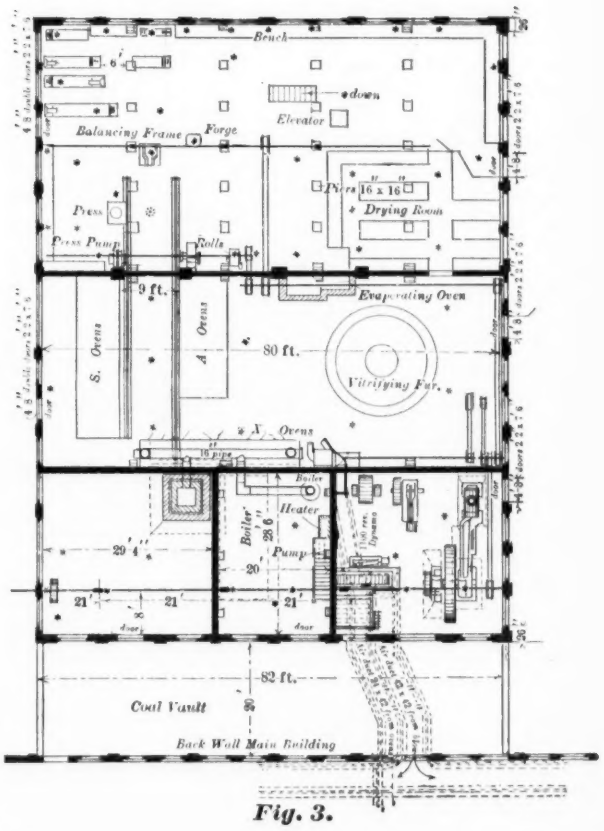

Fig. 3.

The Springfield Emery Wheel Company's New Shops.

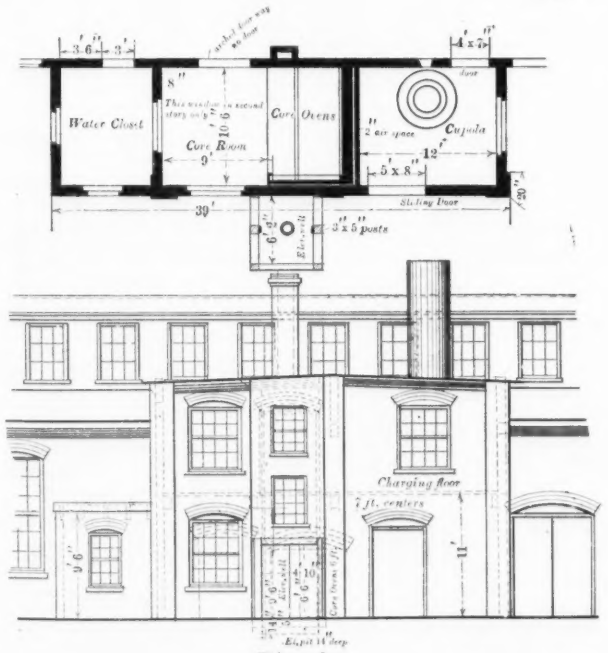

Fig. 4.

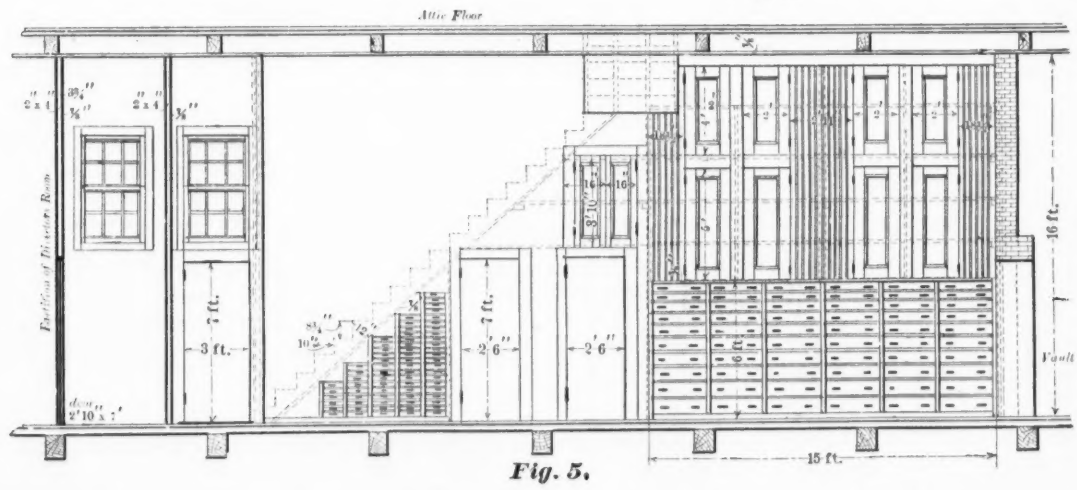

Fig. 5.

especially for electrotypes of the various machines built at the works. These drawers are just deep enough so that they will hold an electrotype, but so that one cannot be placed on top of another, which not only prevents their being bruised and spoiled, but greatly facilitates finding them when wanted, this operation being further facilitated by a small book which hangs near them, in which all are indexed by the number of the drawer in which they are to be found. The other drawers and cupboards seen in this view are also numbered, and an index kept, so that whatever may be in them can be found as readily, no one's memory being depended upon for this. All other arrangements of the offices are in keeping with this, and are such as to facilitate the transaction of business, and make things comfortable. Altogether, we think the company is to be congratulated upon the possession of an excellent plant, and one particularly adapted to their requirements.

Some time ago we spoke of the trial of a dynamite shell in an ordinary gun, using powder as the propelling force, in which the shell exploded within the gun, wrecking it. At the time it was stated that Dr. Justin would procure another gun, and make further trials. This he has done, with the result that another gun is wrecked. This time it was a nine-inch Blakeny rifle which had been used in the defense of Charlestown, and was of English make. The first shot was successful, the shell not exploding until it hit the target; but the second shot destroyed the gun, and sent small fragments of it flying in all directions. It is said that some flaws were found in the steel composing the shell, but it must, we think, be concluded that these experiments make it extremely doubtful whether, in the present state of the arts, dynamite shells can be fired by powder. If the safety of the gun, and everybody within gunshot of it in every direction, must depend upon the absolute perfection of every shell fired, it will, of course, be very difficult to make it even reasonably safe, or to inspire that confidence which is of prime importance for those who make use of a gun in action.

Still, Dr. Justin says he will try again with another gun, and it is by such persistent effort in the face of discouraging circumstances that most of the great successes have been attained.

The companies that furnish brick to builders in New York have had some trouble—that is, four companies have—with some union or other, we don't really know what one. It does not matter, so far as we can see. There were, so far as we can understand the matter, but four companies interested in the fight. But there is an association of brickmakers, embracing many firms, and this association has proceeded very vigorously to boycott every builder in New York. They will not sell them brick under any circumstances, unless these builders proceed to punish some workmen, Heaven knows who. In order to make the boycott more effective, the brick manufacturers propose to cancel all engagements to furnish brick, the association agreeing to pay the damages that may be assessed. Just where the justice of this comes in no one can see. Mind, we have nothing to say against the four companies interested fighting the men engaged in a strike against them, but is it not getting on the borders of a conspiracy; a combination against all the builders in a great city in an effort to make them pull the manufacturers' chestnuts out of the fire? The ethics of strikes, lockouts and boycotts is past finding out, so we may be mistaken in our conclusions.

Machinists' Supplies and Iron.

NEW YORK, Sept. 6, 1890.

Iron—American Pig—There have been no new features developed during the week, consumers not supplied on contract buying only as needed for current consumption. Still the demand for the leading brands keeps pace with production, and furnace men do not accumulate stock to any great extent.

We quote Northern No. 1 Foundry, $17 to $18; No. 2, $16 to $17; Grey Forge, $15 to $15.25; Southern No. 1, $16.50 to $17.25; No. 1, Soft, $16.50 to $16.75; and No. 2, $15.75 to $16.

Scotch Pig—The demand has continued moderate, only small lots changing hands.

We quote Eglinton, $19.25 to $19.75; Dalmellington, $21 to $21.50; Coltness, $23.50 to $24.

Bar—The demand has been moderately good, and prices are without quotable change.

We quote Common, $1.85; Medium, $1.90; Refined, $1.95 to $2 for round lots on dock.

Copper—A steady feeling prevails, the mining companies continuing to take orders for near and future delivery at 17c., though occasional small lots are sold by outsiders at a slightly lower figure. Common casting brands are offered at 14½c. to 14¾c. Arizona, 15½c.

Lead—Only moderate sales are reported, and the market has ruled dull and quiet, though prices have been firmly maintained. Prices rule at 4.75c. to 4.80c. for near by deliveries.

Spelter—There has been no change of importance, the demand remaining quiet, prices being maintained, and with a somewhat firmer tone on account of higher prices abroad.

We quote ordinary brands, Western, 5.50c. to 5.60c.; choice, 5.70c. to 5.75c.; refined, 6.75c. to 7c.; Silesian, 7c. to 7.50c.

Tin—Prices declined in London the first of the week, but have again advanced, and the feeling is firm with higher prices. Quotations for spot deliveries are 22c. to 22¼c.

Antimony—The demand for Regulus has been moderate, and there is no quotable change in values. We quote: Hallett's, 19¾c. to 20c.; Cookson's, 23c.

Lard Oil—There is a steady demand for prime, and prices are maintained at 52c.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Position by machinist while attending Cooper Union. Address C. A. W., AMERICAN MACHINIST

Pattern maker wants position while attending Cooper Union. Address W. F. W., AM. MACHINIST.

Wanted—A position as draftsman, or assistant in general machine business. R. B., AM. MACHINIST.

Wanted—Position by experienced mechanical draftsman. N. L. B., Lock Box 34, Trenton, N. J.

Pattern maker desires change; steady and reliable machine or engine work preferred. Steady, AMERICAN MACHINIST.

Machinist of average ability wants steady job; repair work preferred; some experience on special tools. Box 70, AMERICAN MACHINIST.

Wanted Immediately—Foreman for car-works machine shop; state age, exp., ref's, and salary wanted. Address Car-works, care AM. MACHINIST.

Wanted—Situation as foreman of brass foundry; first-class molder; reference, present situation. Good Work, Box 67, AMERICAN MACHINIST.

Machinists Wanted—First-class floor hands and fitters of large experience and of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, O.

Wanted—As foreman, an experienced and practical man in the manufacture of milled machine screws, etc., for shop in Canada. State salary; references required. Address Box 62, AM. MACHINIST.

Wanted—Good machinists; vise or machine hands; steady work and good wages to first-class men. Address Frick Company, Waynesboro, Franklin Co., Pa.

Wanted—By a machinist and draftsman, situation as foreman or at drawing. Tech. graduate, eight years' exp. Address C. B., care of Benj. Beale, 137 E. Lake street, Chicago, Ills.

Wanted—Fifteen or twenty experienced molders, to make heavy and light castings; state experience, habits, age, and class of work preferred. Steady employment to good men. Address The Canton Steam Pump Co., Canton, Ohio.

Wanted—By young man, position as supt. or foreman of machine works; practical tool maker and machinist; thorough knowledge of Brown & Sharpe's grinders; used to close interchangeable work; best refs. Address Box 13, Simsbury, Conn.

Wanted—A foreman for Blacksmith and Hammer Dept's, at Pittsburgh Locomotive Works, Pittsburgh, Pa. Must be temperate and thoroughly understand the business. State wages expected, and address applications to the Company.

Wanted—Vise hands and fitters on turret lathe work. Steady work to A1 workmen of good habits; new shop with modern tools and sanitary arrangements. Jones & Lamson Machine Co., Springfield, Vt.

Wanted immediately: One good designer and draftsman of practical exp. on metal-working machinery; also planer man, and two good scrapers and filers; we will give steady work to competent men. Fitchburg Machine Works, Fitchburg, Mass.

Wanted—One good brass molder to take charge of brass foundry; one who understands mixing; only first-class men need apply; good salary and steady employment guaranteed. Address The Hawkeye Electric Mfg Co., Davenport, Iowa.

Exp'd mech. draftsmen wanted immediately; those having experience with electrical apparatus preferred; permanency to good men. E. Kolben, Edison Gen. Elec. Co., Schenectady Works, Schenectady, N. Y.

Wanted—A good gear cutter wishes to change; is familiar with Gould & Eberhardt and all other machines. Any one in want of such a man will do well to address Thomas F. Herrick, Husted Court, Providence, R. I.

Partner Wanted—In the oldest established second-hand machinery business and repair shop in Leadville, Col; must be practical; 100 per cent. a year guaranteed on a $5,000 investment. Apply to T. J. Moynahan, Leadville, Col.

Wanted—A competent mechanical engineer, of practical experience, to design and superintend construction of marine engines, comprising high and low pressure, compound and triple-expansion engines, such as are used on the Northwestern lakes. Address Box C, West Duluth, Minn.

Wanted—A first-class foundry foreman in Atlanta, Ga.; a man who thoroughly understands management of men, mixture of metals and general foundry work; first-class wages will be paid; none need apply who are not thoroughly competent in every respect, as their incompetency would be soon known, and would be a loss to them and ourselves. Address, with reference, Box 259, Atlanta, Ga.

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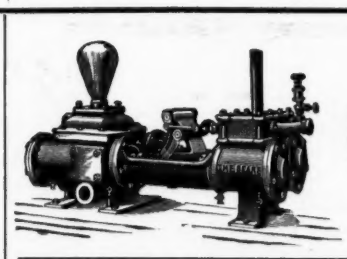

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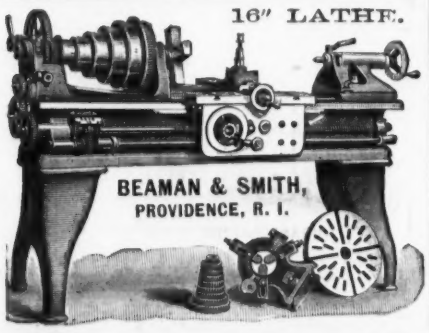

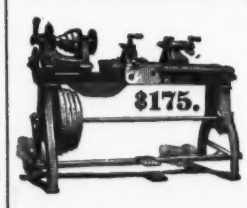

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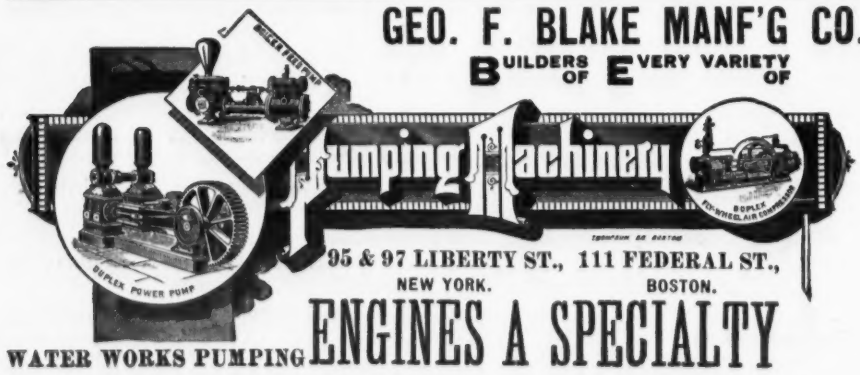

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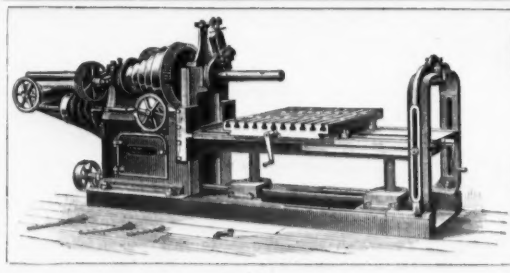

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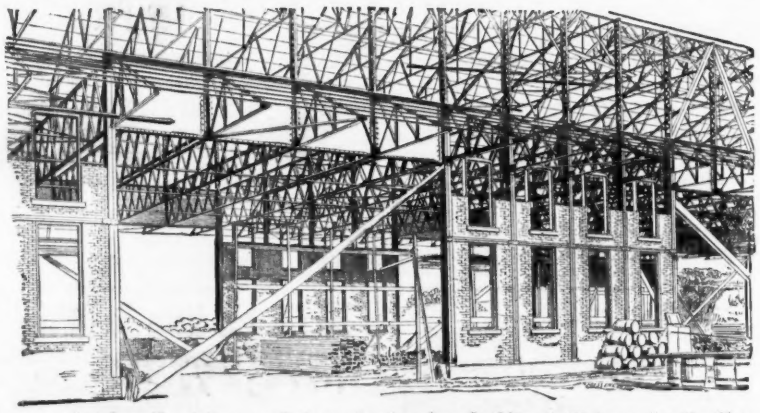

The above cut is taken direct from a photograph of an iron building built by us for the Chesapeake Dry Dock and Construction Company, at Newport News, Va. The photograph is taken during the construction of the work before the walls and floor were placed, in order to show the details of the iron work. Notice that the building is made with iron posts placed 10 ft. apart and thoroughly braced—the intervening space between being filled with a light brick wall. Every 40 ft. there is an opening of 40 ft. in the clear, so that teams can drive into the building to deliver the raw material and take out the finished product. Outside of the main walls there is an overhang 12 ft. in width, so that material can be stored outside of the building and protected from the weather. This plan commends itself for Machine Shops, for the reason that there is considerable saving on foundations, and further, that there is a large saving on the brick work, the walls being supported and strengthened by iron girders so that only a light 8-inch or 12-inch wall is necessary.
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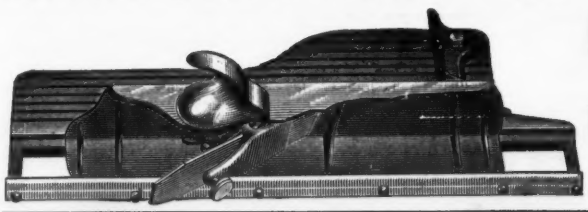

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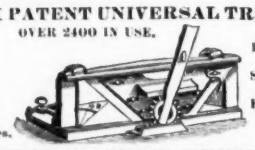

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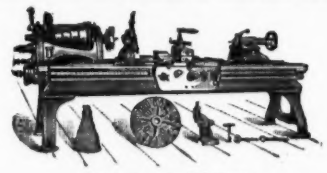

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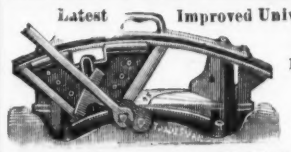

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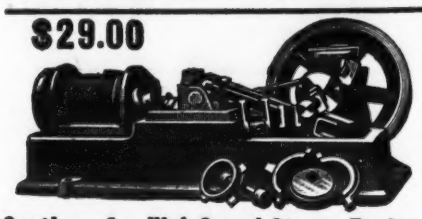

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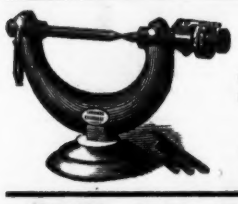

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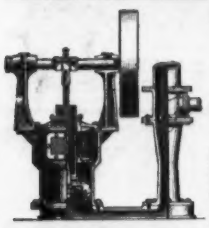

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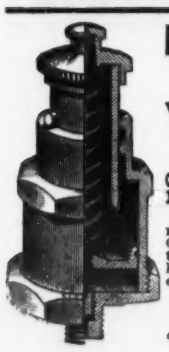

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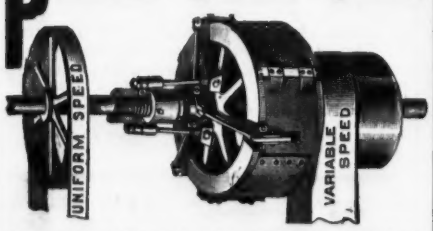

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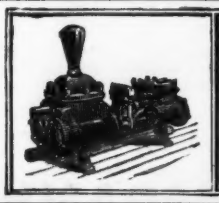

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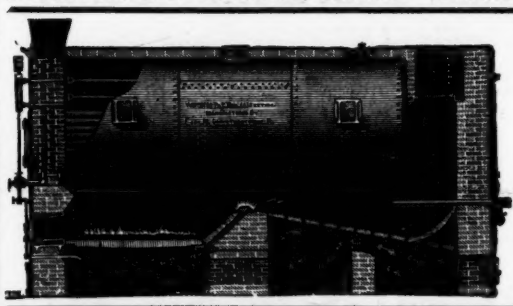

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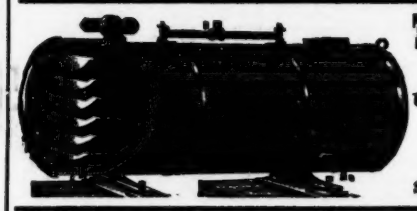

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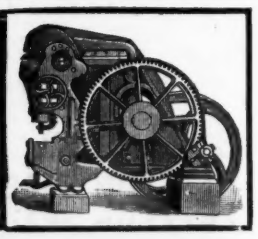

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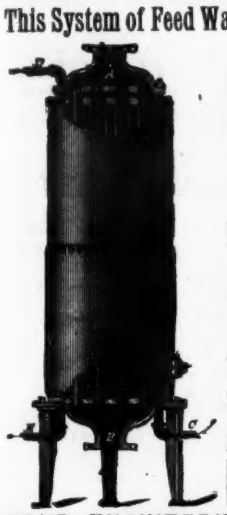

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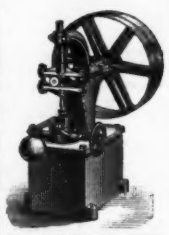

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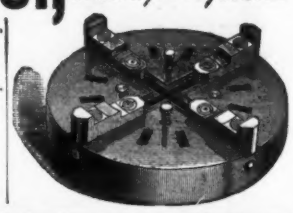

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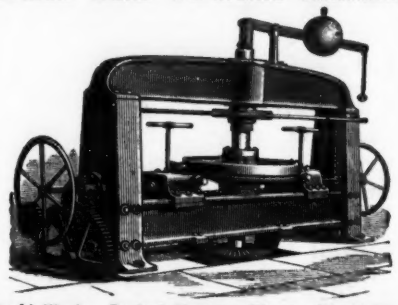

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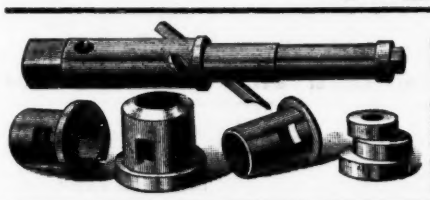

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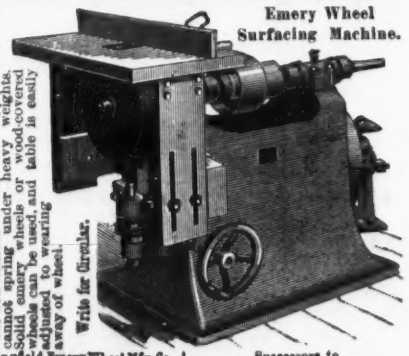

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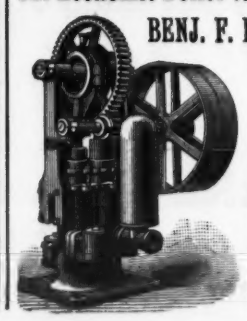

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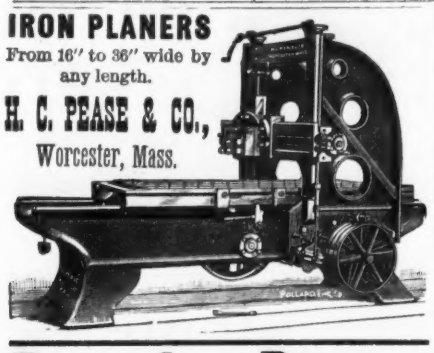

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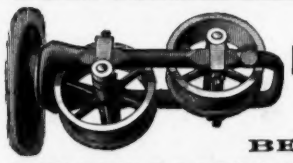

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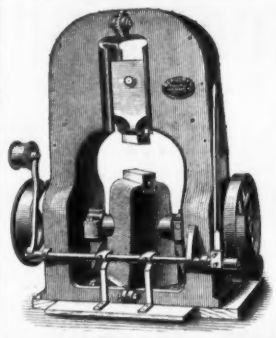

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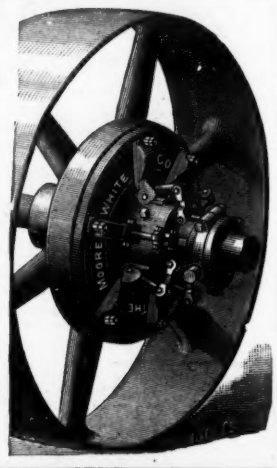

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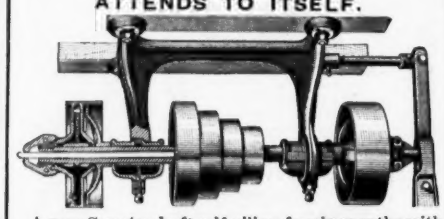

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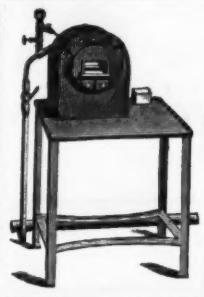

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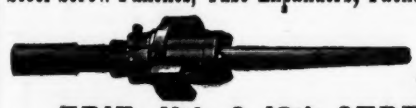

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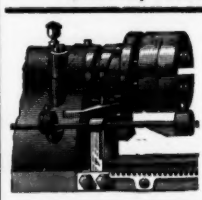

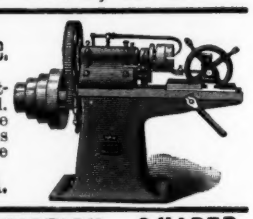

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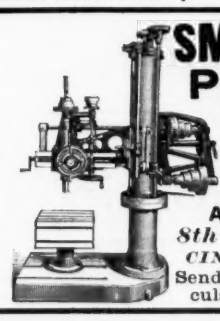

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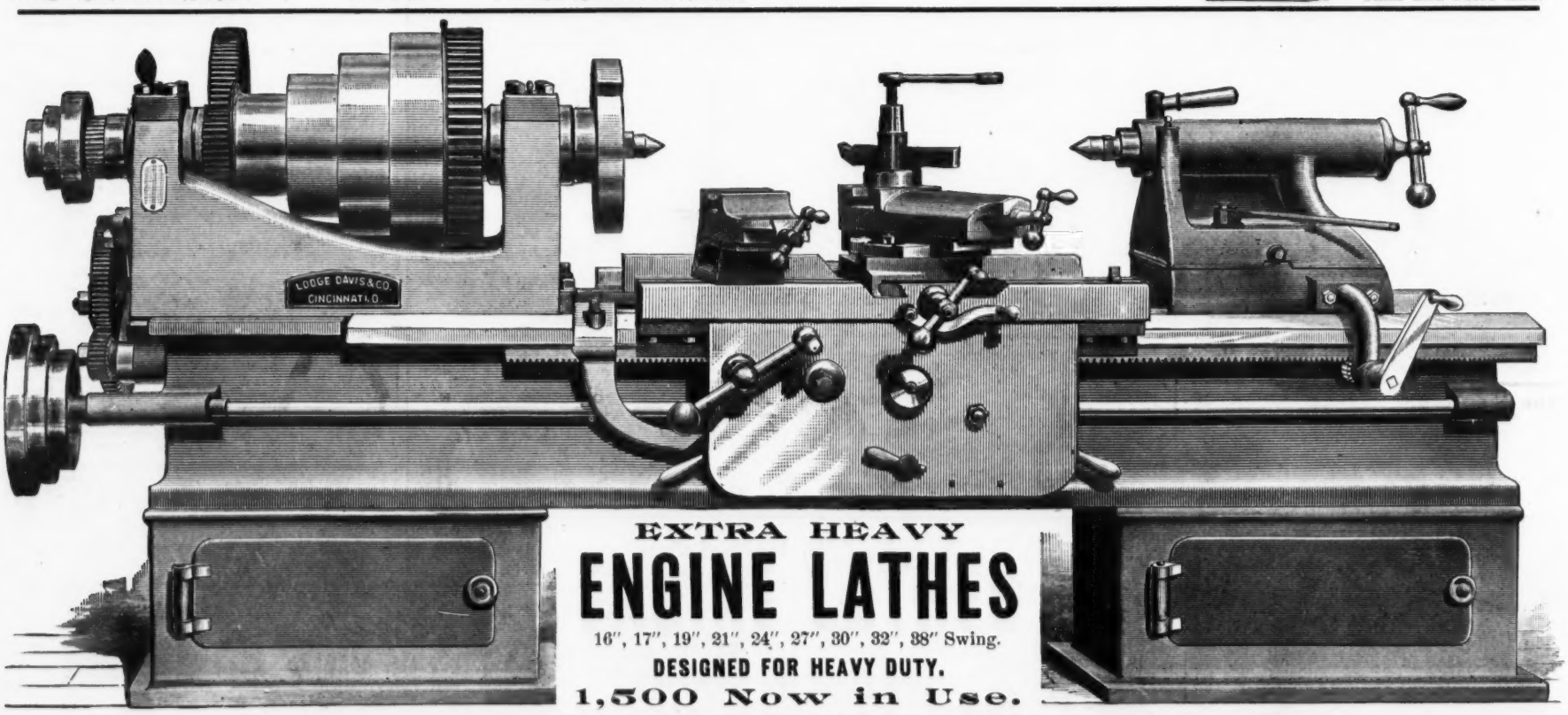

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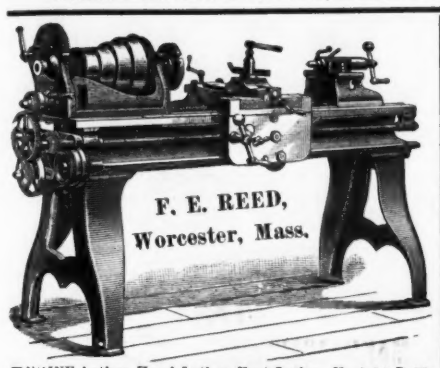

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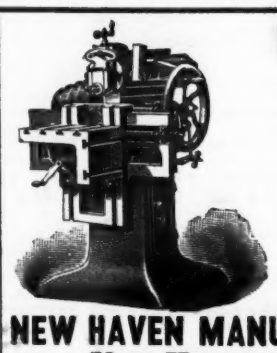

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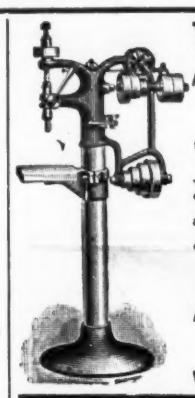

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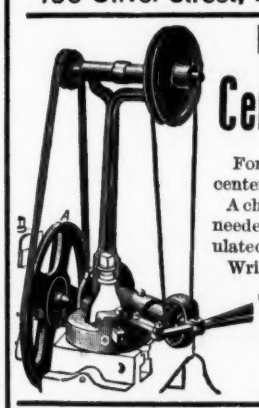

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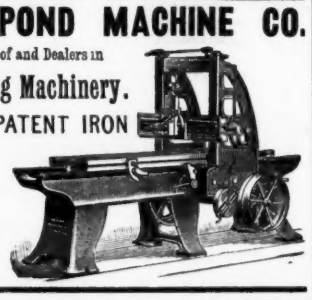

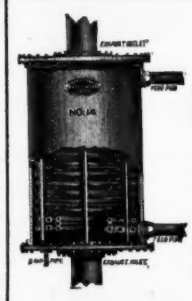

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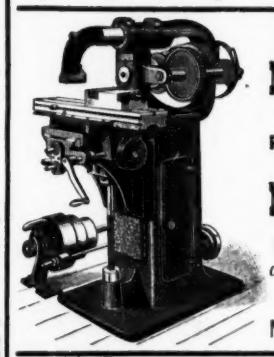

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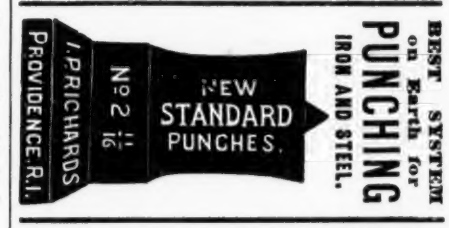

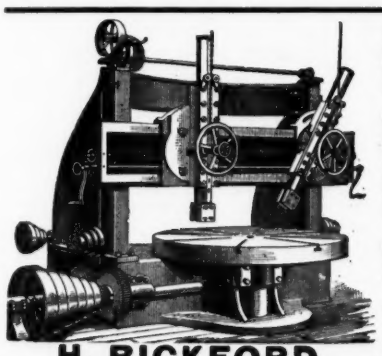

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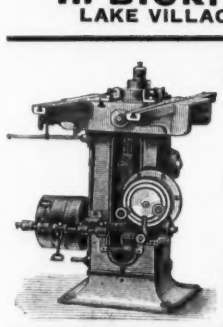

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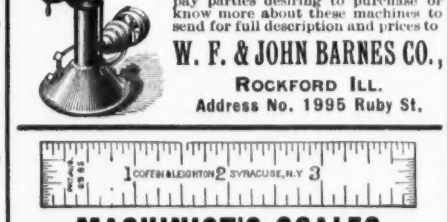

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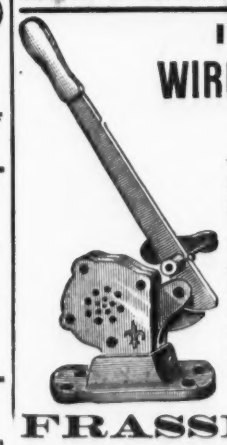

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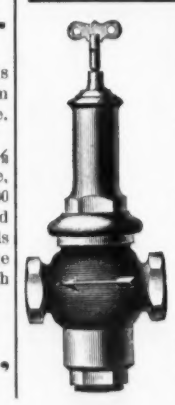

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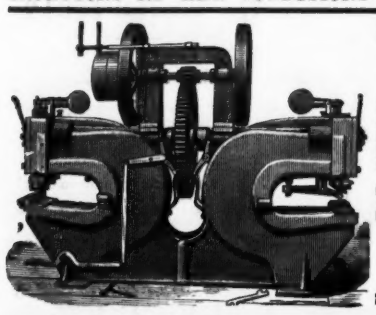

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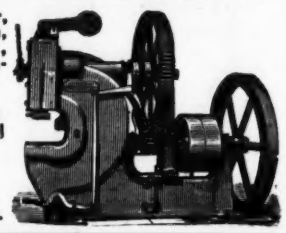

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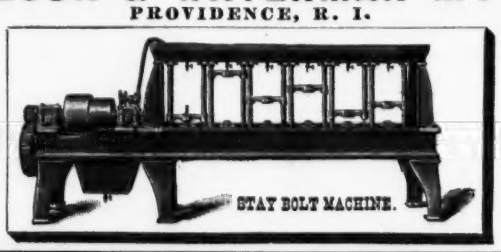

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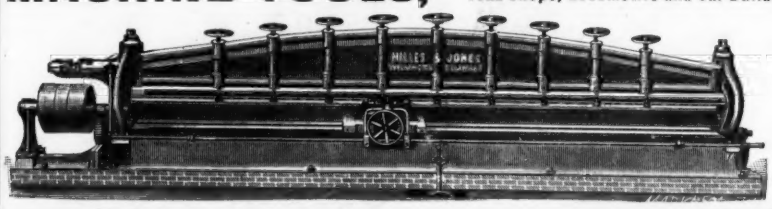

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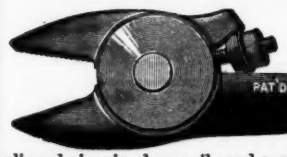

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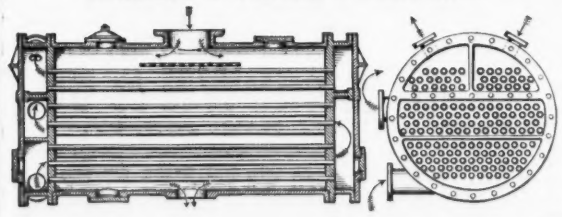

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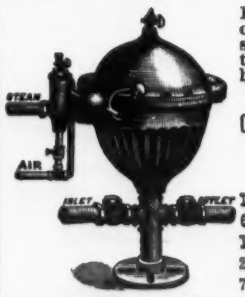

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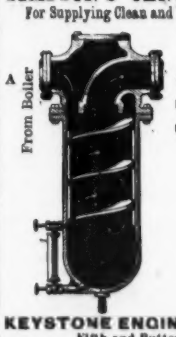

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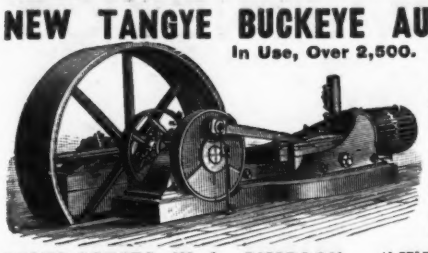

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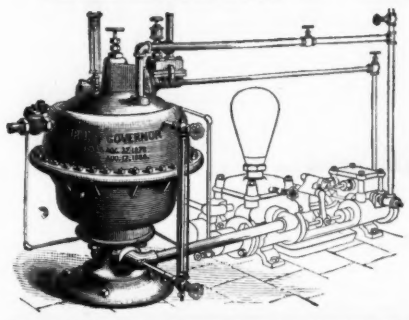

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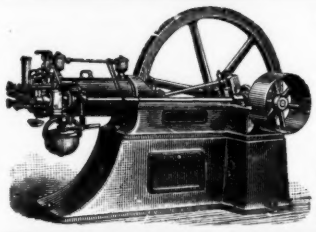

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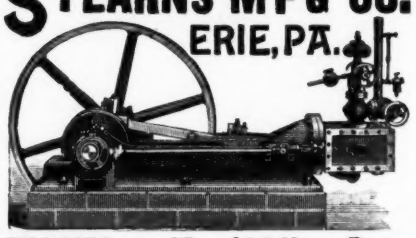

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Ferris & Miles,	"	"	17 in. "	8 ft.	"
New Haven,	"	"	18 in. "	8 ft.	"
Wood & Light,	"	"	20 in. "	7 1-2 ft.	"
Wright,	"	"	20 in. "	22 ft.	"
Townsend	"	"	21 in. "	7 ft.	"
Fifield	"	"	22 in. "	14 ft.	"
New Haven,	"	"	25 in. "	10 ft.	"
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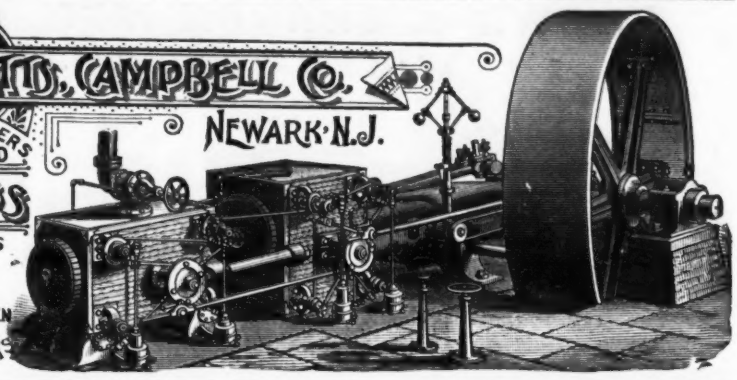

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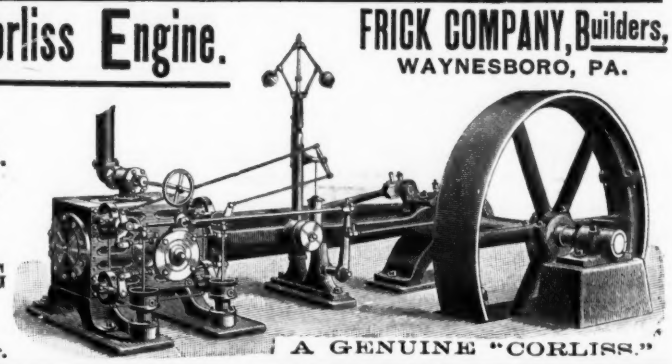

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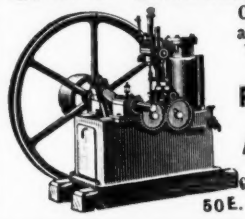

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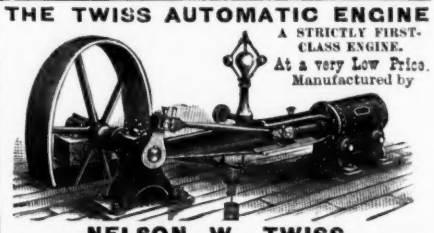

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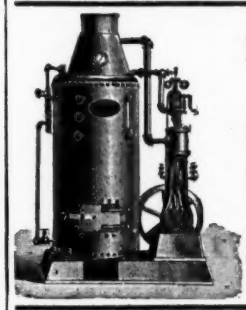

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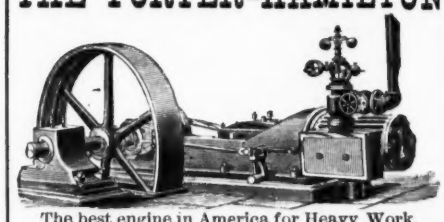

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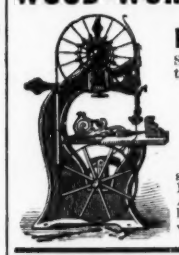

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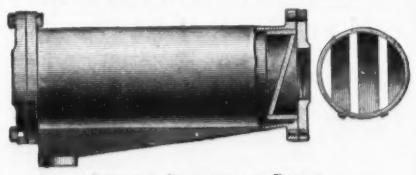

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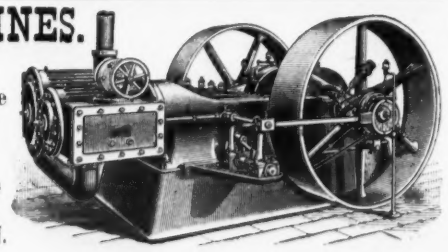

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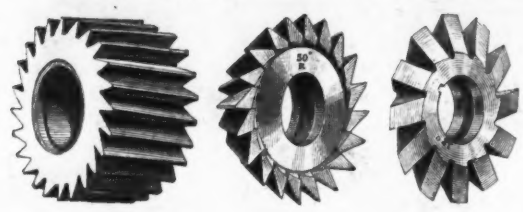

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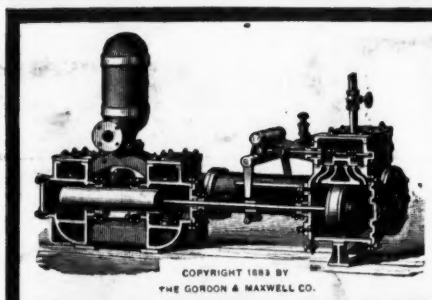

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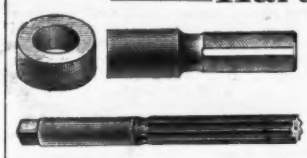

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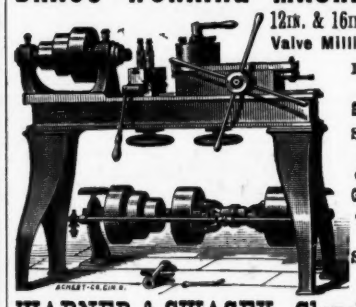

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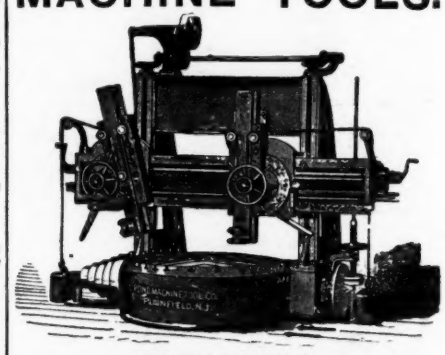

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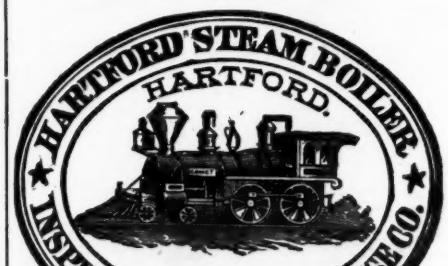

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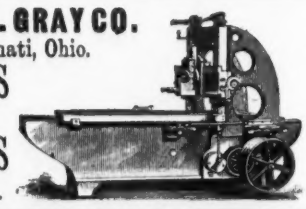

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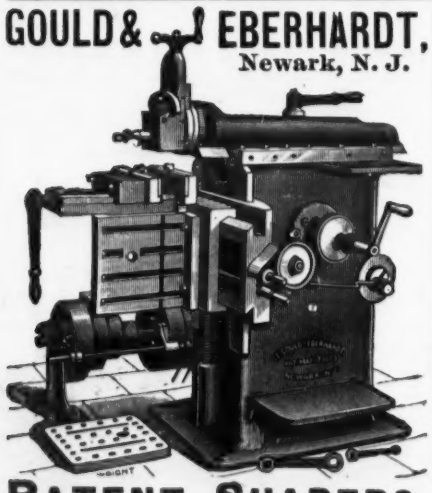

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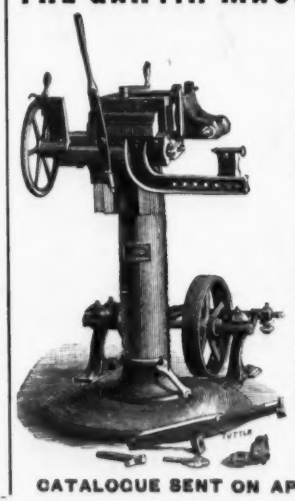

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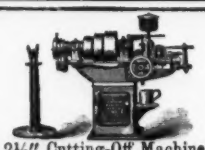

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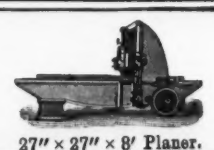

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